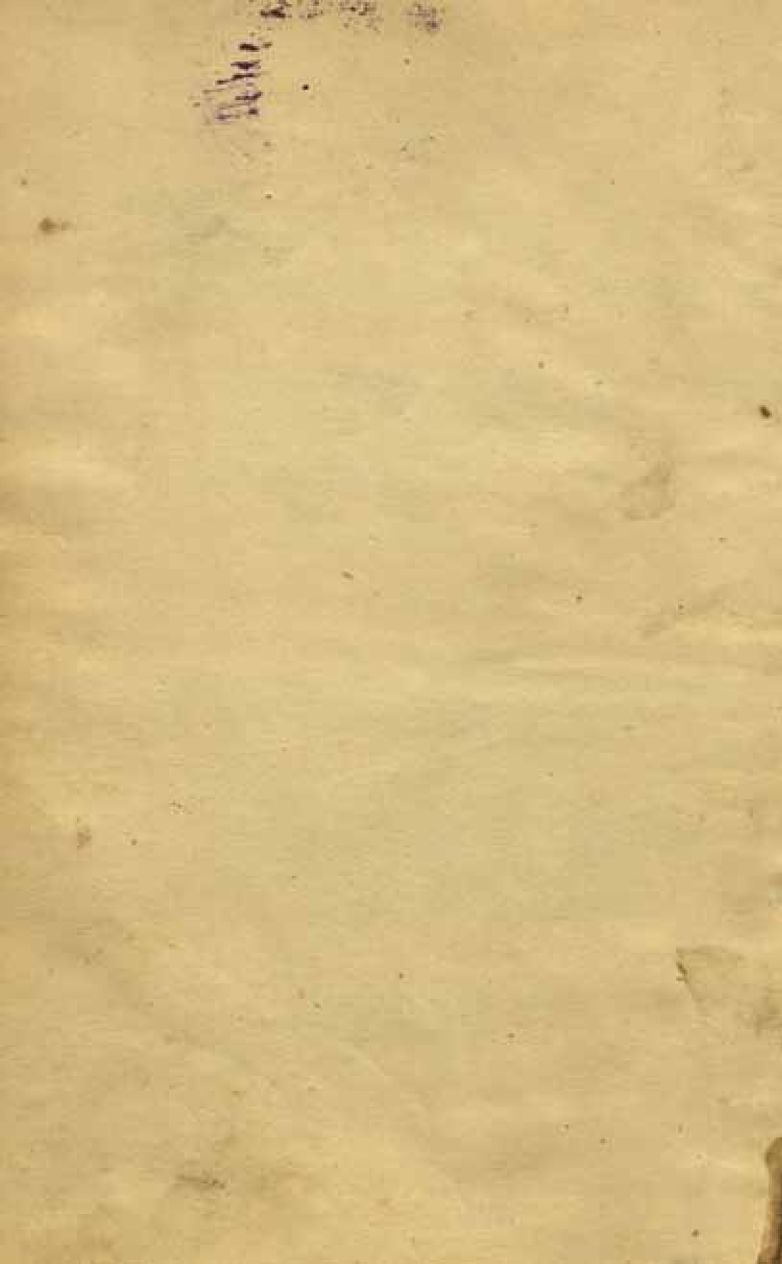



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HISTORY OF HINDU CHEMISTRY

FROM

THE EARLIEST TIMES TO THE MIDDLE OF THE SIXTEENTH CENTURY A.D.

WITH

SANSKRIT TEXTS, VARIANTS, TRANSLATION AND ILLUSTRATIONS

BY

SIR PRAPHULLA CHANDRA RAY, Kt., D.Sc., Ph.D.
Palit Prof. of Chemistry, University College of Science, Calcutta

VOL. I

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PREFACE TO THE FIRST EDITION.

Since the days of Sir W. Jones, Sanskrit literature, in almost every department, has been zealously ransacked by scholars, both European and Indian. As the results of their labours we are now in possession of ample facts and data, which enable us to from some idea of the knowledge of the Hindus of old in the fields of Philosophy and Mathematics including Astronomy, Arthmetic, Algebra, Trigonometry and Geometry. Even Medicine has received some share of attention. Wilson in a series of essays published in the *Oriental Magazine* (1823), Royle in his *Antiquity of Hindu Medicine* (1837), and Wise in his commentary on the *Hindu System of Medicine* (1845), were amongst the first to bring to the notice of the European world the contents of the ancient medical works of the Hindus, and recently the Thakur Sahib of Gondal has added his quota. These contributions are, however, of a fragmentary nature. A comprehensive history of Hindu medicine has yet to be written.

Materia Medica has also found, in Udoy Chand Dutt, an able exponent. One branch has, however, up till this time, remained entirely neglected—namely, Chemistry. Indeed, it may be assumed that on accont of its complex and technical nature it has hitherto repelled investigators.

The progress of chemical knowledge among the ancient nations has always had a fascination for me. The classical works of Thomson, Hoefer and Kopp have been my favourite companions for the last twelve years and more. In the course of my studies in this field I was naturally led to an inquiry into the exact position which India occupies therein, and with this view I undertook a systematic examination, from the chemical standpoint, of the Charaka, the Susruta and the various standard works of the Ayurvedic and Iatro-chemical Periods, which have escaped the ravages of time. It was at this stage that I was brought into communication with M. Berthelot some five years ago—a circumstance which has proved to be a turning-point, if I may so say, in my career as a student of the history of chemistry. The illustrious French savant, the *Doyen* of the chemical world, who has done more than any other person to clear up the sources and trace the progress of chemical science in the West, expressed a strong desire to know all

about the contributions of the Hindus,* and even went the length of making a personal appeal to me to help him with information on the subject. In response to his sacred call I submitted to him, in 1898, a short monograph on Indian alchemy; it was based chiefly on *Rasendrasara Samgraha*, a work which I have since then found to be of minor importance and not calculated to throw much light on the vexed question as to the origin of the Hindu Chemistry. M. Berthelot not only did me the honour of reviewing it at length† but very kindly presented me with a complete set of his monumental work, in three volumes, on the chemistry of the

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*"Cependant il serait nécessaire d'examiner certains documents qui m'ont *été récemment* signalés par une lettre de Rây, professeur à Presidency College (Calcutta). D'après ce savant, il existe des traités d'alchimie, écrits en sanscrit, remontant au XIIIe siècle, et qui renferment des préceptes pour préparer les sulfures de mercure noir et rouge et le calomel employés comme médicaments. Ces indications s'accordent avec celles des alchimistes arabes signalées plus haut. Il est à désirer que ces traités soient soumis à une étude approfondie, pour en déterminer l'origine, probablement attribuable à une tradition persane ou nestorienne."—JOURNAL DES SAVANTS, Oct., 1897.

†"*Matériaux pour un chapitre négligé de l'histoire de la Chimie ou contributions à l'Alchimie indienne* (Mémorie manuscrit de 43 pages), par Prafulla Chandra Rây, professeur à Presidency College, Calcutta."—*Vide* JOURNAL DES SAVANTS, April' 1898

Middle Ages, dealing chiefly with the Arabic and Syrian contributions on the subject, the very existence of which I was not till then aware of. On perusing the contents of these works I was filled with the ambition of supplementing them with one on Hindu Chemistry. Although I have written all along under the inspiration of a mastermind, it is not for a moment pretended that my humble production will at all make an approach to the exemplar set before my eyes.

When I first drew up the scheme of the present work, I had deluded myself with the hope of finishing the study of all the available literature on the subject before I took to writing. But I soon found that the task was one of vast magnitude. Some of my friends, whose judgment is entitled to weight, advised me under the circumstances, to curtail the scope of the work as originally planned out, and present a first instalment of it in its necessarily defective and imperfect shape (see Introduction, p. lxxxiv), reserving for a subsequent volume the working-up of the materials which are accumulating from time to time. In the present volume only one or two representative works of the Tanric and Iatro-chemical Periods have been noticed at length.

As regards the transliteration, I have not rigidly adhered to any particular system, but, in the

main, I have followed that of the *Sacred Books of the East*.

Before concluding, I must acknowledge the valuable assistance I have received rom Pandit Navakānta Kavibhusa*n*a with whom I have toiled through many an obscure passage of the Mss. of the *Tantras*. His sound knowledge of the *Ayurvedas* has also been of much help to me.

* * * *

And now it only remains for me to discharge the grateful duty of expressing my thanks to the Government of Bengal, which at the instance of Mr. Alexander Pedler, F. R. S., Director of Public Instruction, placed a liberal grant at my disposal to enable me to meet various incidental expences, chiefly in the matter of collecting rare Mss.

PRESIDENCY COLLEGE:
Calcutta, May 1st, 1902.

P. C. RAY.

PREFACE TO THE SECOND EDITION.

A comparatively limited number of copies was printed in the first edition as it was feared that owing to its technical nature the work would appeal only to a select circle of readers. The exceedingly favourable reception accorded to it not only by the scientists and orientalists but also by the public in general both in Europe and in India has necessitated the bringing-out of a second edition. Some material additions have been made to the historical portion of the Introduction, throwing further light on the independent origin of the Hindu system of medicine and its priority to that of the Greeks.

M. Berthelot, in the course of a lengthy and appreciative review in the "Journal des Savants," Jan. 1903, expresses his regret at the absence of "any thing which would remind us of the systematic treatises of Zosimus and of the Greco-Egyptians" —a regret which will be shared in by every student of Hindu chemistry. But even the sable cloud is not without its silver lining. I hope, however, to deal with the theories underlying Hindu chemistry in the second volume. For the present, I have to

content myself with the pronouncement of my respected and learned friend, Mr. Brajendranātha Seal Principal, Mahārājā's College, Kuch Behar, whose vast acquaintance with and comprehensive grasp of, the literature of the East and the West, entitles him to speak with authority on the subject. Says Mr. Seal in his plea for our University "striking out a line of communication with the organisations of oriental learning."—

"Let us not superciliously dismiss these studies as 'learned lumber.' The Astronomy and Mathematics were not less advanced than those of Tycho Brahe, Cardan and Fermat; the anatomy was equal to that of Vesalius, the Hindu logic and methodology more advanced than that of Ramus, and equal on the whole to Bacon's; the physico-chemical theories as to combustion, heat, chemical affinity, clearer, more rational, and more original than those of Van Helmont or Stahl; and the Grammar, whether of Sanskrit or Prākrit, the most scientific and comprehensive in the world before Bopp, Rask and Grimm."

PRESIDENCY COLLEGE: P. C. RAY.
January 1, 1904.

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CHAPTER I

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Erratum : Intro., p. civ, the 3 lines from the bottom upwards are to be deleted

Introduction

CHAPTER I

Alchemical Ideas in the Vedas

Dawn of Hindu Alchemy.

IN tracing the progress of chemical knowledge among the civilized nations of old, one always finds it intimately associated with medicinal preparations, metallurgical operations, the technical arts and the belief in the transmutation of metals. In India, more so than in Europe, chemistry has, however, been evolved chiefly as a handmaid of medicine; and, somewhat later on, as an adjunct of the Tantric cult. The efficacy of the drug alone was by no means considered sufficient unless backed by the kindly interposition of the deities. Thus in the *Rigveda* we find the Asvins, the divine physicians, invoked, who give sight to the blind and make the lame walk. These twin gods have many points in common with the Dioskouroi of Greek mythology. One very

curious myth is that of the maiden Vi*s*palá who, having had her leg cut off in some conflict, was at once furnished by the A*s*vins with an iron limb.

The higher gods of the *Rig*veda are almost entirely personifications of the elements and the other natural phenomena, such as the fire and the wind, the sun and the dawn. But we often find also herbs and plants endowed with potent and active properties, raised to the dignities of the gods and addressed as such. The Soma plant is an object of particular adoration and the Vedic worshippers are in ecstacy over the exhilarating effects of the fermented juice expressed from it.[1] The Soma rasa (juice) began even to be regarded as the am*ri*ta; this immortal draught, allied to the Greek *ambrosia*, is "the stimulant which conferred immortality upon the gods . . . it is medicine for a sick man and the god Soma heals whatever is

1) See Eggeling's Intro. to" *Satapatha Bráhmana*." Pt. 11, pp. 1 *et seq*. also Roth; Ueber den Soma; "Zeit. deut. morg. Ges." XXXV. pp. 680-692; also ibid, XXXVIII. 134-139: Wo wächst der Soma? And Windischmann: Ueber den Somacultus der

sick." It will be seen later on that in the Soma rasa and its attributes we have the dawn of Hindu Alchemy (*Vide* p. 79).

Other plants were likewise invoked as divinities. Thus one entire hymn is devoted to the praise of plants *(oshadhi)* alone, mainly with regard to their healing powers. [1]

Arier : Abhand. d. Münch. AK. d. Wiss. IV. B. Abh. 2.

(1) One or two typical hymns may be quoted here :—

या ओषधीः पूर्व्वा जाता देवेभ्यस्त्रियुगं पुरा।
मनै नु बभ्रूणामहं शतं धामानि सप्त च
शतं वो अम्ब धामानि सहस्रमुत वो रुहः। X.97.1.
अधा शतक्रत्वो यूयमिमं मे अगदं कृत॥ *ibid.*, 2

Sáyana's commentary to the above is :—

याः ओषधयः पूर्व्वाः पुरातन्यः जाताः उत्पन्नाः, केभ्यः सकाशात्? देवेभ्यः; यद्वा देवाः द्योतमानाः ऋतवः, तेभ्यः। कस्मिन् काले? त्रियुगं त्रिषु युगेषु प्रादुर्भावापेक्षया कृतादियुगत्रयमुक्तं, कलौ तु अधर्म्मप्रचुरत्वात् उपेक्षितम्। अथवा त्रिषु युगेषु वसन्ते प्रावृषि शरदि चेत्यर्थः। अहं बभ्रूणां बभ्रुवर्णानां सोमाद्योषधीनां शतं सप्त च धामानि अनुलेपमार्जनाभिषेकादिरूपेण आश्रयभूतानि स्थानानि नु क्षिप्रं मनै मन्ये संभावयामीत्यर्थः।

हे अम्ब मातरः ओषधयः वो युष्माकं धामानि स्थानानि जन्मानि वा शतम् अपरिमितानि; उतापि च वो युष्माकं रुहः प्ररोहः प्रोद्गमः सहस्रपरिमिताः। अधा अपि च हे शतक्रत्वः हे शतकर्म्माणः यूयमिमं मे मां मदीयं वा जनम् आमयवन्तम् अगदं गदः रोगः तद्रहितं कृत कुरुत।

Again, in another hymn we read: "O King Varu*n*a! a hundred and a thousand medicinal drugs are thine."

It is in the "Atharva-veda" however, that plants and vegetable products in general are fully recognised as helpful agents in the treatment of diseases, though their use is invariably associated with the employment of charms, spells, and incantations. Thus the plant apámárga *(achyranthes aspera)*, which still occupies a prominent place in the Hindu system of medicine as a di-uretic and laxative etc., is invoked as the "mistress of remedies" (IV. 17, 1.) and "sole ruler over all plants." In another hymn the Soma plant is thus referred to:—

"The strength of this am*r*ita (ambrosia) do we give this man to drink. Moreover, I prepare a remedy, that he may live a hundred years!"

Again, "as many (plants), as the human physicians know to contain a remedy, so many, endowed with every healing quality, do I apply

to thee!"[1] Here is a spell for the cure of leprosy by means of a dark-coloured plant :—

Born in the night art thou, O herb,
Dark-coloured, sable, black of hue:
Rich-tinted, tinge this leprosy,
And stain away its spots of grey! (I.23,1).
—Macdonell

There is also a distinct reference to a remedy for promoting the growth of hair.

"As a goddess upon the goddess earth thou wast born, O plant! We dig thee up, O nitatní, that thou mayest strengthen (the growth) of the hair.

"Strengthen the (old hair), beget the new! That which has come forth render more luxurious!" VI. 136. 1-2.

The Healing Arts differentiated.

Although in the Vedic age caste as a hereditary system did not exist, the healing arts had evidently acquired sufficient importance to be pursued by particular members of the patriarchal families. Thus with that charming sim-

(1) Bloomfield: "Hymns of the Atharva-veda" pp. 43-44.

plicity which is the characteristic beauty of the *Ri*gveda, one *Ri*shi says pathetically of himself :

"Behold I am a composer of hymns, my father is a physician, my mother grinds corn on stone. We are all engaged in different occupations [1]" (IX. 112, 3),

"Princes like Divodása, and bards and leaders of the tribe of the Angiras, administered medicines and gloried in effecting cures. A skilled physician is distinctly defined as one who lives in a place abounding with medicinal plants, and who assiduously devotes his time to the acquisition of knowledge [2]."

The earlist literary record of Indian Medicine.

Thus not only in the Atharvan but even in the *Rik*, we can trace the earliest literary record of Indian Medicine.

The "Atharva-veda" deals chiefly with sorcery, witch-craft and demonology. There are deadly imprecations against evil-doers ;

(1) R. C. Dutt : "Civilisation in ancient India," p. 65 (Calc. ed.)

(2) Introduction to "A*s*t*á*ñgah*ri*daya" of Vagbha*t*a, by Anna Morsvar Kunte, B. A., M. D., p. 2.

magical incantations for bringing about ruin, death, dementation and stupefaction of one's adversaries; and charms intended to secure the love of women through the potency of various herbs. Some of them are of hostile character, being meant to injure rivals. The picture here presented has its counterpart in the ancient Egyptians, who were noted for their magical lore to which the Greeks were no less attached. There is a close resemblance between the contents of the A. V. and those of the Papyrus of Leyden in some essential features. In the latter also there is an intermixture of magic, astrology, alchemy as well as recipes for love philters.[1]

The A. V., on account of its frequent calling-in-aid of super-natural agencies forselfish and malevolent purposes, has not generally been accorded the canonical sanctity of the Vedic Triad—The *Rik*, the Yajus and the Sáman; the very authority of the fourth Veda as a

(1) The reader may compare this portion with Berthelot's "Les Origines de l' Alchimie," pp. 81-83.

scripture has been questioned in the several law-books of the Apastamba, the Vishnu, the Yájñavalkya and the Manu schools, and the practices it sanctions strongly condemned.

As Hindu medicine has seldom been able to shake itself completely free from the influence of magic and alchemy as auxiliaries, physicians, as practicers of the "black art," have been given an inferior position in the legal treatises. The Mahábhárata, reflecting the spirit of the above law-books, regards the physicians as impure. In spite of this "the Atharvan retains in a measure its place by virtue of its profound hold upon popular beliefs, because the Atharvan performs, especially for the king, inestimable services in the injury and overthrow of enemies."[1]

Rasáyana or Alchemy.

In the A. V., the hymns for the cure of diseases and possession by demons of disease are known as "bhaishajyáni,' while those which have for

(1) Bloomfield's "Hymns of the Atharva-veda":—Introduction, p. XLVI.

their object the securing of long life and health are known as "áyushyáṇi"—a term which later on gave place to rasayana, the Sanskrit equivalent of alchemy (see p. 80). We shall quote two under the latter heading as invocations to pearl and its shell and gold respectively. "Born in the heavens, born in the sea, brought on from the river (Sindhu), this shell, born of gold, is our life-prolonging amulet."

"The bone of the gods turned into pearl; that, animated, dwells in waters. That do I fasten upon thee unto life, lustre, strength, longevity, unto a life lasting a hundred autumns. May the (amulet) of pearl protect thee!"

"The gold which is born from fire,[1] the immortal, they bestowed upon the mortals. He who knows this deserves it: of old age dies he who wears it."

"The gold, (endowed by) the sun with beautiful colour, which the men of yore, rich in descendants, did desire, may it gleaming

(1) Among the five kinds of gold referred to in the "Rasaratnasamuchchaya" (p. 105), वह्निसम्भवं (born from fire) is one.

envelop thee in lustre! Long-lived becomes he who wears it!"

While gold is regarded as the elixir of life, lead is looked upon as the dispeller of sorcery: "To the lead Varu*n*a gives blessing, to the lead Agni gives help. Indra gave me the lead; unfailingly it dispels sorcery."[1]

It is of interest to note the alchemical notions which had gathered round gold and lead[2] at the time of the A. V.

To the student of Hindu medicine and alchemy, the A. V. is thus of special interest as the earliest repository of information on the subject.

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(1) The quotations are from Bloomfield's A. V. pp. 62-65.

(2) In the alchemy of the West, lead, as is well known, is associated not with beneficient but "Saturnine" influence.

CHAPTER II

The Ayurvedic Period

We now alight upon a period when we find the Hindu system of medicine methodised and arranged on a rational basis, with a scientific terminology.

The Hindu system of medicine methodised and arranged on a rational basis.

The two great works of this period are the Charaka and the Susruta. In them we find the study of the subject to have made a distinct advance and to have been evolved out of the chaotic state it was in during the Vedic period. Of the two, the Charaka is by far the more ancient. [1]

There must have been a wide gap between the age of the A. V. and that of the Charaka—an interval of probably a thousand years or more.

The Charaka and the Susruta.

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(1) Cf. "The theological doctrine of the nature of disease indicated its means of cure. For Hippocrates was reserved the great glory of destroying them both, replacing them by more practical and

In the latter the humoral pathology is fully developed, the diagnosis and prognosis of diseases described at length, and an elaborate mode of classification adopted. We have seen above that the physicians were assigned rather an inferior status in society; the healing art was, in fact, never recognised as a division of the Vedas.[1] Still the claims of the indispensable science of medicine, which can be distinctly traced to the A. V., could not altogether be ignored, and ultimately a compromise was arrived at. In the Charaka itself the Science of Life

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material ideas, and, from the votive tablets, traditions, and other sources, together with his own admirable observations, compiling a body of medicine. The necessary consequence of his great success was the separation of the pursuits of the physician from those of the priest. Not that so great a revolution, implying the diversion of profitable gains from the ancient channel, could have been accomplished without a struggle. We should reverence the memory of Hippocrates for the complete manner in which he effected that object."—Draper's "Hist. of the Intellect. Dev. in Europe," I. p. 393 (ed. 1896). The services rendered by Charaka, Susruta and their predecessors were equally valuable.

(1) The six *limbs* or divisions of the Vedas are sikshá (phonetics), kalpa (ceremonial), vyákarana (grammar), nirukta (etymology), chhandas (metre) and jyotisha (astronomy).

(*A*yurveda) is regarded as a secondary or subsidiary branch (*upánga*) of the Atharvan and as a direct revelation of the gods (Sútra : Ch. XXX. 8-9).

The Susruta even goes a step further and asserts that the self-existent (Brahmá) created *A*yurveda, as an *upánga* of the Atharvan (sútra : 1. 3.)

The age of Charaka.

We shall now concern ourselves with finding the time of Charaka within approximate limits. The task is not a light one, and it is one of the most abstruse questions of Indian chronology.

M. Sylvain Lévi has recently unearthed from the Chinese Tripitaka the name of a physician named Charaka, who was attached as spiritual guide to the Indo-Scythian King Kanishka, who reigned in the second century A. D. The French Orientalist would have this Charaka as the author of the famous Hindu medical work, specially as it would offer an easy explanation of the supposed Greek influence discernible in it.

'Les éléments traditionnels mis en œuvre par les conteurs peuvent se résumer ainsi: le roi devaputra Kanishka, de la race des Kusha*n*as, règne sur les Yuetchi, sept cents ans après le Nirvâ*n*a; il est assisté de ministers éminents, nommés Devadharma et Mâ*t*hara. Le bodhisattva A*s*vaghosha est son conseiller spirituel; l'illustre médecin Charaka est attaché à sa personne."

* * * *

"La mention de Charaka est la première indication positive obtenue sur la date du savant praticien qui dispute à Su*s*ruta la gloire d'avoir fondé la science médicale dans l'Inde. Les influences grecques qu'on avait cru reconnaître dans les doctrines de Charaka s'expliquent aisément, s'il est vrai que ce grand médecin vivait au temps et à la cour des Indo-Scythes, alors que l'hellénisme semblait pénétrer en vainqueur dans la vieille civilisation brahmanique."

——"Journ. Asiatique" (1896), T. VIII. pp. 447-51

We confess we are by no means convinced of M. Lévi's theory. If we are to go by *name* alone, we can claim a still higher antiquity for our author. The appellation of Charaka occurs in Vedic literature as a patronymic; in short, Pá*n*ini felt it necessary to

compose a special sútra for deriving the "Charakás" *i.e.* the followers of Charaka.[1] Then again, Patañjali, who is now generally admitted to have lived in the second century B. C., is known to have written a commentary on the medical work of Charaka, thus further proving the antiquity of our author;[2] and both Chakrapáni and Bhoja agree in alluding to him as the redactor of Charaka.[3] Indeed, in such matters we would do well to set store by native traditions. It would be beside our purpose, however, to enter into any lengthy discussion on the grounds on which we are inclined to place Charaka in the pre-Buddhistic era, but we shall summarise below the salient points.

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(1) कठचरकाल्लुक् । 4. 3. 107.

(2) आप्तो नाम अनुभवेन वस्तुतत्त्वस्य कार्त्स्न्येन निश्चयवान्, रागादिवशादपि नान्यथावादी यः स इति चरके पतञ्जलिः । Quoted in the "Laghu Mañjushá" of Nágesa Bha*tt*a.

(3) पातञ्जल-महाभाष्य-चरकप्रतिसंस्कृतैः ।
मनोवाक्-कायदोषाणां हन्त्रेऽहिपतये नमः ॥

Vide salutation in the commentary named आयुर्वेददीपिका on the Charaka by Chakrapáni.

Evidence based upon the handling of the subject-matter.

In the handling of the subject-matter the Charaka is not so systematic as the Susruta, but indulges in random, hap-hazard and irrelevant discourses, which make the reader often lose the thread of the main narrative. The author, whenever he has an opportunity, boldly and with evident relish, launches into metaphysical disquisitions, which, he believes, make up for lack of experiments and observations.[1] In this respect the Susruta is far more scientific than the Charaka. The Nyáya and the Vaiseshika systems of philosophy, which have been interwoven into the body of the text, again remind us of a stage when they were more or less in a state of flux, but had not crystallised into the well-defined form and shape of the sútras in which they have come down to us–this also

(1) This has given ample scope to a recent commentator, the late Kavirája Gangádhara Kaviratna, who in his जल्पकल्पतरु, surpasses Charaka himself in philosophical dissertations.

goes towards proving the high antiquity of the Charaka.[1]

Again, only Vedic gods and mantras figure in the Charaka, not a trace of Pauranic mythology being discernible in it.[2] Charaka follows closely the Vedic authority[3] in counting the number of bones in the human body; the

Absence of Pauranic mythology

(1) The Nyáya of Gotama enumerates 16 padárthas (categories), while Charaka under his (medical) disputation, वादमार्ग, mentions 44 categories (*Vide* Vimána. Ch. VIII. 22., also A. C. Kaviratna's Eng. trans. pp. 564-65). Bodas in his learned Introduction to the Tarkasamgraha of Annambhatta (pp. 12-14) places the aphorisms of Gotama and Kanada in the period between 400 B. C. to 500 A. D.

(2) The names of *Krishna* and Vásudeva occur in a salutation in the supplement added by *Dridhavala*. Chikitsita. Ch. 21. 92-93. ed. Gañgádhara). But *Krisna*-worship was in vogue at the time of Pánini; 4. 3. 98. See also Lassen's Alterthumskunde 1. p. 648. Bühler also points out that "the earlier history of the puránas, which as yet is a mystery, will only be cleared up when a real history of the orthodox Hindu sects, especially of the Sivites and Vishnuites, has been written. It will, then, probably become apparent that the origin of these sects reaches back far beyond the rise of Buddhism and Jainism."—Intro. to "Apastamba," &c. p. XXIX..

(3) Namely 360; Sárira. Ch. VII. 5. According to the Institutes of Vishnu "it (the human frame) is kept together by three

limit of childhood he takes to be thirty years—quite in keeping with the conception of the heroic age.

It should, however, be borne in mind that the Charaka, as we now possess it, can by no means lay claim to be the first comprehensive and systematic treatise on Hindu medicine, it represents rather a more or less final development of the subject, just as the elaborate grammar of Páṇini is based upon some twenty previous works of his predecessors, notably of Yáska, *S*ákalya, *S*ákatáyana, Gárgya and others.

The above has its parallel in the history of Greek medicine anterior to the time of Hippocrates. As Draper observes:

Writings of Hippocrates.

"Of the works attributed to Hippocrates, many are doubtless the production of his family, his descendants, or his pupils. The inducements to literary forgery in the times of the Ptolemies, who paid very high prices

hundred and sixty bones" (XCVI. 55). This has been adduced by Jolly as a "reason in favour of the high antiquity of its laws." Vide Intro. to Vishnu, pp. XVIII-XX. See also Jolly's "Medicine" (Grundriss), p. 42.

for books of reputation, have been the cause of much difficulty among critics in determining such questions of authorship. The works indisputably written by Hippocrates display an extent of knowledge answering to the authority of his name; his vivid descriptions have never been excelled, if indeed they have ever been equalled. The Hippocratic face of the dying is still retained in our medical treatises in the original terms, without any improvement."

Still more appropriate are the remarks of Littré on the works which now bear the name of "the father of medicine."

"Lorsqu'on recherche l'histoire de la médecine et les commencements de la science, le premier corps de doctrine que l'on rencontre, est la collection d'écrits connue sous le nom d'œuvres d'Hippocrate. La science remonte directement à cette origine et s'y arrête. Ce n'est pas qu'elle n'eût été cultivée antérieurement, et qu'elle n'eût donné lieu à des productions même nombreuses; mais tout ce qui avait été fait avant le médecin de Cos a péri. Il ne nous en reste que des fragments épars et sans coordination; seuls, les ouvrages hippocratiques ont échappé à la destruction; et, par une circonstance assez singulière, il existe une grande lacune après eux, comme il en existait une avant eux: les

travaux des médecins, d'Hippocrate à l'établissement de l'école d'Alexandrie, ceux de cette école même ont péri complétement, à part des citations et des passages conservés dans des écrivains postérieurs; de telle sorte que les écrits hippocratiques demeurent isolés au milieu des débris de l'antique littérature médicale.

and internal evidence. Of internal evidence the first notable, feature is the style.

The simple, unvarnished prose of the Charaka reminds one of the Bráhmanas of the Vedas. Thanks to the researches of Bühler and Fleet, we have now some idea of the prose Kábya style as it existed in the second century A. D. The literary prose inscriptions discovered at Girnár and Násik, although less ornate and artificial than the romances of Subandhu and Vána (seventh century A. D)., abound in long-winded metaphors and alliterations and thus stand in bold constrast with the simple prose of the Charaka.

Between the period of the A. V. and that of the Charaka there must have been com-

posed several medical treatises, each reflecting the spirit and progress of its age[1]. At the time of the Charaka itself there existed at least six standard works by Agnive*s*a, Bhela, Játukar*n*a, Parásara, Hárita, and Kshárapá*n*i, respectively. Charaka simply based his work on that of Agnive*s*a[2], which he completely recast and remodelled. Later on, D*r*i*dh*avala added the last forty-one chapters[3]. The other five works seem to have perished[4]. Vágbha*t*a,

(1) We are at present engaged in examining the Bráhmanas, the Upanishadas and Buddhistic literature with a view to glean information on these points and hope to announce the results in the second volume.

(2) Charaka himself naïvely assigns his reasons for giving preference to the treatise of Agnivesa in the words :—"of the six (authors) Agnivesa was the most "sharp of intellect" (sútra Ch. I 2.)

(3) विस्तारयति लेशोक्तं संक्षिपत्यतिविस्तरम् ।
संस्कर्ता कुरुते तन्त्रं पुराणं च पुनर्नवम् ॥ Siddhi. Ch. XII. 28.

Also Chikitsita, Ch. XXX. 112 ; ed. D. N. Sen and U. N. Sen.

(4) Cf. "We know how often in India the appearance of a convenient abstract has led to the neglect and subsequent loss of all earlier works on the subject."—Intro. to Stein's Rájataránginí, p. 25. In Burnell's Tanjore catalogue Pt. I. pp. 63-65 a full analysis is given of Bhelasamhita, from which it would appear that this work is still extant, though in a mutilated form. Dr. Burnell

the epitomiser of the Charaka and the Susruta, mentions the works of Hárita and Bhela, which were probably extant in his days.

On reading the Charaka, one often feels as if it embodies the deliberations of an international Congress of medical experts, held in the Himálayan regions to which even distant Balkh (Bactriana) sent a repersentative in the person of Kámkháyana (see p. 25). The work professes to be more or less of the nature of a record of the Proceedings of such a Congress.[1]

Bodas in discussing the philosophical disquisitions of the Bráhmanas observes :

"It was a special function of the Brahmá priest to give decisions on any disputed points that may

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remarks; "the most superficial comparison shows how much Vágbhata was indebted to this ancient work."

An "Hárita Samhitá has recently been published; but its authenticity is questionable.

(1) Cf. 'La lecture de cet ouvrage nous initie aux compte-rendus de véritables congrès philosophiques et médicaux, dans lesquels des maîtres accourus des points les plus éloignés de l'Inde et même de l'etranger, prennent successivement la parole."—Quelques Données Nouvelles a propos des Traités médicaux Sanscrits antérieurs au XIIIe siècle, par P. Cordier, p. 3.

arise in the course of a sacrifice, and this he could not have done unless he was a master of ratiocination. Such decisions, which may be likened to the chairman's rulings in a modern assembly, are scattered through the ancient Brāhmaṇas, and are collected together as so many Nyāyas in the Pūrva Mímāṃsa aphorisms of Jaimini." [1]

We would invite the reader to go through the "Discourse on the Tastes" (pp. 25-28) and he will naturally agree that the above remarks apply with equal force to our author. In short, judging both from the manner and the matter of the work, we have little hesitation in placing it in the pre-Buddhistic era. We shall revert to the subject under Suśruta.

The age of Suśruta.

As regards the Suśruta we are on more solid grounds. Its terminology and *technique*, in general, do not differ much from those of the Charaka. In style the Suśruta is rather dry, pithy, laconic, and matter-of-fact, as the Charaka is discursive and diffuse, and its composition altogether would point to a much later date.

(1) Intro. to Annaṃbhaṭṭa's Tarkasaṃgraha, *p. 28*.

This is easily accounted for. The Susruta, such as has been preserved to us, is generally held to be a comparatively modern recension by the celebrated Buddhist Chemist, Nágárjuna,[1] who is said to have added the Uttaratantra or the Supplement.[2] Here for the first time in the history of Hindu Medicine and Chemistry, we come accross a personage who is historical rather than mythical (see below). That the redactor thoroughly recast and remodelled the Susruta is evident from the fact that there are numerous passages in it which agree almost *verbatim* with the Charaka, and which appears to have been amply laid under contribution.

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(1) "यत्र यत्र परोक्षे लिट्प्रयोगस्तत्रैव प्रतिसंस्कर्तृसूत्रं ज्ञातव्यमिति प्रतिसंस्कर्तापीह नागार्जुन एव "*Vide Dalvana*'s commentary.

(2) Cf. "It is said; by *Dalvanách*árya, the commentator of Susruta, that at the time of war between the Bauddhas and Hindus, the Susrutatantra was re-edited and rendered more comprehensive by the renowned chemist Siddhanágárjuna with a supplement called "uttaratantra." Since that period it has been known by the name of Susruta Samhita." Intreduction to "Vaidyakasabdasindhu" p. 6. by Kavirája Umesachandra Gupta Kaviratna.

The Susruta is *par excellence* a treatise on surgery [1] as the Charaka is on medicine proper. Ancient India must have acquired considerable skill in the handling of the lancet; for in the Charaka we find a distinction drawn between the "Káyachikitsakas," *i. e.* the physicians properly so called, and the "Dhanvantvarisampradáyas" *i. e.* followers of Dhanvantvarí or the Chirurgeons—a distinction which we have already noticed in the beginning of the Vedic Age.

The age of Susruta has been the subject of animated controversy for a long time past. The Hindus regard this branch of Ayurveda as a direct revelation from the Asvins or the Divine Surgeons (see p. i, Intro.). The origin of this myth can be traced to the *Rig*veda as already seen. In the Mahábhárata, Susruta is spoken of as the son of the sage Visvámitra and in the "Várttikas" of Kátyáyana (about 4th century B. C.) we

(1) For a description of the surgical intstruments together with their drawings, see Wise: "Commentary on the Hindu System of Medicine, (1845) pp. 168-170.

also find mention of the same name. It is not, however, easy to establish any connection between these names and our present author. That there was a V*ri*ddha (old) Su*s*ruta, exisiting as early as the fifth century A. D., has now been established almost beyond doubt. Dr. Hoernle, to whose profound scholarship and indefatigable labours the world is indebted for the excellent edition of the Bower Ms., has deduced from palæographic evidence that it must have been copied within the period from about 400 A. D. to 500 A. D. [1]—a conclusion at which Próf. Bühler has independently arrived. The work professes to be by Su*s*ruta, to whom it was declared by the Muni Ká*s*iníja. The origin of the Ayurveda as given in the Bower Ms., is on much the same lines as in the Charaka and the mention in it, among others, of such names as Hárita, Bhela, Parí*s*ara, and the A*s*vins as founders of the science of medicine, would go to prove

(1) On the date of the Bower Ms., See "Journ. As. Soc." LX. Pt. 1. p. 79.

that even so early as the 5th century A. D., the old Susruta had come to be regarded as of mythical origin, and that therefore it must have been composed many centuries anterior to that time. Several important recipes as given in the Bower Ms., *e. g.* those of the "chyavanaprása," "*s*ilájatuprayoga" (the doctrine of bitumen p. 53) etc., occur in practically identical recensions in the Charaka. This is easily accounted for. The Charaka, the Susruta, and the Bower Ms., and even the Ash*t*áṅgah*ri*daya of Vágbha*t*a have more or less a common basis or substratum. In order to understand this point more clearly it is only necessary to refer for a moment to the legal literature of the Hindus. The "Mánava Dharma*s*ástra" or the Institutes of Manu, which still exercises a potent influence in the regulation of the social life of the Hindus, is by no means the ancient work that it pretends to be. Modern research has shown that it is only a recension, or rather a recension of a recension, of "Dharmasútras" connected with the Vedic Schools, incorpora

ting at the same time the laws and usages of the age at which it was remodelled.[1]

It would equally be a great mistake to suppose that the knowledge—chemical and therapeutical—which our Susruta embodies is only representative of the time of its final redaction. As a matter of fact it is a repository of the informations on the subject accumulated from the Vedic age to the date of its final recasting.

The remarks of M. Berthelot regarding a Greek technical treatise, which, from palæographic evidence, seems to have been written about the 11th century A. D., apply with still greater force to the Susruta.

"En effet la date de rédaction originelle n'est certainement pas le même pour les divers articles que le traité renferme : les uns étant plus anciens et remontant parfois jusqu'à l'antiquité gréco Egyptienne ; tandis que les autres reproduisent des recettes postérieures et des additions peut-être contemporaines du dernier copiste. En tous cas, ce traité continue la vieille tradition de l'orfèvrerie

(1) Vide Bühler's Introduction to "the Laws of Manu" : pp. XVIII et seq. "Sacred Books of the East," Vol. XXV.

alchimique, qui remonte aux anciens Egyptiens."—"Coll. des anciens alch. Grecs.," t. iii., trad. p. 307.

The period when the Su*s*rura received its final cast must always remain an open question. Vágbha*t*a in his Ashtáñgah*ri*daya makes copious extracts both from the Charaka and the Su*s*ruta. The latter must therefore have existed in their present form prior to the 9th century A. D. Mádhavakara in his Nidána quotes bodily from the Uttaratantra, and as the Nidána was one of the medical works which were translated for the Caliphs of Bagdad (see below), it can safely be placed in the 8th century at the latest. In is thus evident that the present redaction of the Su*s*ruta must have existed anterior to that date, and that it had become at that age stereotyped as it were. The Vágbha*t*a and the Nidána are simply summaries of the Charaka and Su*s*ruta,[1] and were written at a time when

(1) This statement we make in a qualified sense, and we fully agree with Roth when he observes "Udoy Chand Dutt in seiner Mat. Med. bezeichnet das Werk als eine methodische geordnete Compilation aus Charaka und Su*s*ruta. Ich glaube er thut ihm damit Unrecht; Vágbha*t*a der sich übrigens mehr an

the latter had become very old, and were therefore studied by few experts, and their abstracts were likely to be prized by the general practitioners.

Vágbha*t*a concludes his masterly treatise with the following observation, which is highly significant :—

*Vágbha*t*a's apologia.*

" If a work is to pass current as authoritative simply because it is the production of a sage of old, why are the treatises of Charaka and Su*s*ruta alone studied and not those of Bhela and others[1] ? It thus follows that whatever is reasonable [methodical and scientific] is to be preferred."[2]

Read between the lines the above is to be taken as an apology on the part of our author for appearing in the field ; it further establishes clearly that even during his life-

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Susruta hält, ist nicht so unselbständig." "Zeit. deut. morg. Ges." 49. p. 184.

(1) *e.g* Játukarna, Parásara, Ksharapáni, etc. see p. xxi.

(2) ऋषिप्रणीते प्रीतिश्चेन्मुक्त्वा चरकसुश्रुतौ ।
भेडाद्याः किं न पठ्यन्ते तस्माद्ग्राह्यं सुभाषितम् ।"

time the Charaka and the Susruta were regarded *as hoary with the prescription of age*, and their memories had passed into the region of tradition.[1]

The commentators of Susruta.

The earliest commentary of the Susruta that has been partially preserved to us is known as the Bhánumati by Chakrapáni Datta, the celebrated author of the medical work which goes by his name (about 1060 A. D). The other well-known commentary, the Nibandha Samgraha, is by Dalvana, who lived in the reign of Sahanapála Deva whose kingdom was situated somewhere near Muttra. Dalvana acknowledges his obligations to the previous commentators, namely Jejjata, Gayadása, Bháskara, and Mádhava whose dates it is not easy to ascertain.

The purity of the text.

Since a remote period the text of the Susruta has been jealously preserved and no tampering with it tolerated. Thus Dalvana refuses to

(1) On the age of Vágbhata see below under its proper heading.

recognise the authenticity of a passage, because an ancient commentator, Jejja*t*a, has not noticed it.[1]

Haas on the age of Susruta

We have been at some pains in arriving at an approximate age of the composition of the Sus*r*uta, because attempts have been made now and then by a certain school of European scholars to prove that the medical works of the Hindus are of comparatively recent date. Haas has propounded the bold and astounding theory that the systematic development of Hindu medicine took place between the tenth and sixteenth centuries A. D.[2] We

(1) अनार्षोऽयं श्लोकः, जेज्जटाचार्येण नोक्तत्वात् । तस्मान्न पठनीयम् ।

Chikitsita. VII. 3.

Many such instances may be cited. For the purity of the text we are much indebted to these commentators.

(2) Kehren wir nunmehr wieder zur historischen Frage zurück, so konnen wir jetzt einen Anfangs—und einen Endpunkt aufstellen, zwischen welche wir mit einiger Sicherheit das Entstehen der systematischen Wissenschafft der Medizin bei den Indiern verlegen müssen, nämlich den Zietraum von der Mitte des 10. bis Zur Mitte des 15. Jahrhunderts.—"Ueber die Ursprünge der Indischen Medizin, mit besonderem Bezug auf Susruta." "Zeit. deut. morg. Ges." XXX. p. 642.

shall see later on that this is precisely the period which marks the *decadence* of the Hindu intellect in the field of medicine and mathematics.[1] We should not have thought it necessary to discuss seriously the various arguments which Haas adduces in support of his views, some of which Dr. Hoernle curtly disposes of as "an elaborate joke," were it not for the fact that this German critic represents a school which cannot or will not see anything in India, which can claim originality or antiquity. In his blind zeal to support this theory, Haas has been led into the most egregious blunders. He comes to the strange conclusion that the works of Vágbhaṭa, Mádhava and Śárṅgadhara and others supply the germs, out of which the Charaka and Susruta have been elaborated, forgetting or ignoring that the former repeatedly and gratefully acknowledge their indebtedness to the latter.

(1) *Vide* "Decline of Scientific Spirit" pp. 190-198.

Haas is anxious to prove that the Hindus borrowed their notions of humoral pathology from the Greeks, and that the *origines* of Indian Medicine are to be looked for in the writings of Galen and Hippocrates; indeed he goes so far as to suggest that the very name of Susruta is derived from the Arabic word Sukrat (=Sokrates), which is often confounded with Bukrat, the Arabic corruption of the Greek Hippocrates.[1] There is certainly a strange similarity between the chapter on "Initiation" in the Charaka and the "Eides" of Æsculapius as pointed out by Roth,[2] and there is also much in common between the doctrine of humoral pathology of

and the origin of Indian medicine.

(1) No less preposterous is the etymology of Kâsi (Benares), which Haas derives from Kos, the native place of Hippocrates.

(2) "Indische Medicin: Charaka," Z., D. M. G., Vol. 26. p. 441. Roth, whose knowledge of the Vedic and, to a certain extent, of the Ayurvedic, literature was encyclopedic, simply points out the analogy and stops short there. M. Liétard, who evidently borrows his information from Roth's article, jumps at once to the conclusion that the Hindus owe their inspiration to the Greeks!—Bull. de l'Acâd. de Méd. Paris, May 5, 1896 and May 11, 1897.

the Greeks and the Hindus respectively—suggesting that borrowing may have taken place on one side or the other. But the Hindus would seem to have priority of time in their favour.

The doctrine of humoral pathology.

The doctrine of humoral pathology or at any rate the first beginnings of it can be traced so far back as the time of the *Ri*gveda.[1]

In the Atharva-veda, which may be looked upon as the parent of the Ayurveda, we naturally come across ample evidences of an ingrained belief in the causation of diseases by the disturbance of the humors. Thus we have such terms as "Vátík*ri*ta," *i.e.* a disease brought on by the derangement of the humor "Váta" (wind or air), "Vátagul-min," &c.[2]

(1) * * * त्रिधातु शर्म वहतं शुभस्पती ॥ 1. 34. 5. ?

Sáya*n*a's commentary to the above:—

हे शुभस्पती शोभनस्य औषधजातस्य पालकौ युवां त्रिधातु वात-पित्तश्लेष्मशमनविषयं शर्म सुखं वहतं प्रापयतम् ।

(2) This has been lately pointed out by Jolly ("Medicine" p 41): The discussion on the term quoted above is so very important that we think it desirable to quoted it at length :—

Early Buddhist literature also furnishes us with abundant proofs of this nature. On going through the chapter on "Medicaments" in the Mahávagga, we are often reminded of the contents of the Susruta.[1] From Pánini

pre-Budhistic in origin.

"The history of the interpretation of this hymn is of uncommon interest, because it illustrates forcibly the particular closeness of relation between the hymns of the Atharvan and the practices reported in connection with them. Professor Weber, Indische Studien, IV, p. 405, translated the hymn under the caption 'Gegen hitziges fieber,' and guided especially by the more immediate meaning of *garâyugâh*, 'the product of the placenta, after-birth,' he thought that the hymn referred to puerperal fever, or the fever of a child. Ludwig, Der Rigveda, III, p. 343, surmised that the hymn was directed aginst inflammation, and Zimmer, Altindisches Leben, p. 390, refers to it in connection with the word vâta in the first stanza, which he would translate by 'wound;' he also identifies váta with 'wound' etymologically. The compound vátabhrâgâs in the first stanza, as he understands, means 'suffering from wound-fever.' But Zimmer's theory that the word váta ever means 'wound' has not sustained itself: váta is 'wind in the body;' vátikritanáśanî (VI,44,3[3]) is 'destroyer of the disease which comes from wind (of the body);' cf. báta byádhi (vátavyádhi), 'diseases produced by wind (in the body),' in Wise's Hindu System of Medicine, p. 250, and see Contributions, Fourth Series, Amer. Journ. Phil. XII, p. 427." Bloomfield's A. V. p. 246.

(1) One or two instances may be quoted here :—"Now at that time a certain Bhikkhu had a superfluity of humors in his body" —Vinaya Texts; pt. II. p. 60.

also we can glean technical terms as used in the Ayurveda, suggesting that a system of medicine existed in his life-time.[1]

Positive historical evidence.

We have thus what amounts to positive historical evidence that during the life-time of Buddha and even much earlier the doctrine of humoral pathology and the Ayurvedic method of

"And the blessed one said to the venerable *Ánanda*: 'A disturbance, *Ánanda*, has befallen the humors of the Thathágata's body"—*ibid*, p. 191.

The various kinds of salts used in medicine as also the eye ointments, to wit, black collyrium [stibium], rasa ointment [rasáñjana], sota ointment [srotañjana] &c. *ibid.* p. 90, are exactly the same as prescribed in the Susruta and other works on Hindu Medicine. (See also under añjanas, p. 93 of this book).

Note specially the reference to *vatthikamma* which is a Páli corruption of the Sanskrit *vastikarma*:

"Now at that time the Chhabbaggiya Bhikkhus, since a surgical operation had been forbidden by the Blessed One, used a clyster."

No body has yet been bold enough to suggest that in the Mahávagga Greek influence can be traced.

(1) The very terms Ayurveda and Ayurvedika *i.e.* expert in the Ayurveda occur in Pánini. We give below a list of some of the technical terms.

[illegible]: ४।१,८८; परिमाणान्तस्यासंज्ञा-शाणयोः ७।३।१७; खार्याः प्राचाम् ५।४।१००; खार्या ईकन् ५।१।३३;

treatment were in vogue.[1]

In the Várttikas of Kátyáyana also (4th to 3rd century B. C.) the three humours of váta (air), pitta (bile) and sleshman (phlegm) are ranked together.

Regarding the age of the Vinaya Text, Rhys Davids and Oldenburg say:

"The Vibhanga and the Twenty Khandhakas were at that time (circa 350 B. C.) already held in such high repute that no one ventured to alter

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[illegible] ५ । १ । १२३ ; लोमादिपामादिपिच्छादिभ्यः शनेलचः ५ । २ । १०० , सिध्मादिभ्यश्च ५ । २ । ९७ ; रोगाच्चापनयने ५ । ४ । ४९ ; कालप्रयोजनाद्रोगे ५ । २ । ८१ ; अर्श आदिभ्योऽच् ५ । २ । १२७ ; रोगाख्यायां ण्वुल् बहुलम् ३ । ३ । १०८ ; कच्छ्वादिभ्यश्च ४ । २ । १०२ ।

(1) The Jívaka Komárabhachcha, who treats Buddha, derives his surname from "kaumárabhritya," a technical term for one of the eight divisions (astángas) of Ayurveda, meaning *treatment of infants*. *Vide* the Mahávagga, pt. 11, p. 174.

In Asvaghosha's "Life of Buddha" we also read: "Atri, the *Rishi*, not understanding the sectional treatise on medicine, afterwards begat Átreya, who was able to control diseases."—Beal's trans. p. 11. This Átreya (Punarvasu) may have been the same sage who taught Agnivesa.

(2) Weber's "Hist. Sanks. Lit." p. 266, Eng. trans. ed. 1892.

them; a sanctity of this kind is not acquired without the lapse of a considerable time: and we think it is not going too far to say, Firstly, that these books must have been in existence, as we now have them, within thirty years, earlier or later, of, at least, 360 or 370 B. C." (Intro. p. xxiii).

The question of priority settled for good.

It is therefore evident that almost before the birth of Hippocrates, the Hindus had elaborated a system of medicine based upon the humoral pathology. And yet Hass would have it that the Greeks, in the field of medicine as in several others, were the "pioneers and the first teachers of the world."[1]

M Liétard very justly observes that if it could be proved that the doctrine of humoral

(1) "Wenn aber einmal der Boden von der Vorstellung geräumt ist, dass die Araber den Susruta und Charaka schon im 9. Jahrh. gekannt haben müssen, und wenn auf der andern Seite sich herausstellte, dass die Theorien der indischen Autoritäten in ihren Grundzügen mit denen des Galen übereinstimmten, so stünde nichts der Annahme im Wege, dass auch auf diesem Felde, wie auf so vielen andern die Griechen wieder das bahnbrechende Volk und die ersten Lehrmeister der Welt gewesen sind":—Z. D. M. G. Vol. 30. p. 670.

pathology was broached in India anterior to the time of Hippocrates, not only would the originality of the Hindus be established, but that of the Greeks would be compromised thereby.[1] The question may therefore be now taken as settled for good.

Concluding remarks.

The capacity of a nation must be judged by what it has independently achieved in the several fields of knowledge and branches of literature—Mathematics, including Arithmetic and Algebra, Geometry, and Astronomy; Phonetics, Philology, Grammar, Law, Philosophy, and Theology.

Cantor, the historian of mathematics, was so much struck with the resemblance between Greek geometry and the *Sulva sútras* that he, as is natural to the European, concluded that the latter were influenced by the Alex-

(1) "Il est évident que si l'on arrivait un jour à pouvoir reporter jusqu'au delà de l'époque d'Hippocrate, la formation de la doctrine médicale indienne, son originalité serait incontestable, mais, du même coup, celle de la médecine grecque serait fort compromise, puisque, comme je le rappellerai dans un instant, les theories sont à peu près identiques de part et d'autre."

andrian school of Hero (215 B. C.). The *Sulva sútras*, however, date from about the 8th century B. C., and Dr. Thibaut has shown that the geometrical theorem of the 47th proposition, Bk. I., which tradition ascribes to Pythagoras, was solved by the Hindus at least two centuries earlier,[1] thus confirming the conclusion of v. Schroeder that the Greek philosopher owed his inspiration to India.[2] Nor must we forget that the most scientific grammar that the world has ever produced, with its alphabet based on thoroughly phonetic principles, was composed in India about the 7th or 8th century B. C.[3] As Professor Macdonell remarks: "we Europeans.............................2500 years later, and in a scientific age, still employ an alphabet which is not only inadequate to represent all the sounds of our

(1) Journ. As. Soc. Beng. 1875. p. 227.

(2) In his learned work "Pythagoras und die Inder." pp. 44-59.

(3) See Goldstücker: "Pánini: his place in Sanskrit Literature."

language, but even preserves the random order in which vowels and consonants are jumbled up as they were in the Greek adaptation of the primitive Semitic arrangement of 3000 years ago."

It is curious to reflect that the upholders of the "Greek Culture" are often found ready, though unconsciously, to twist and torture facts and conclusions to serve their own purpose, and reserve to themselves the benefit of doubt as regards date; but whenever the priority of the Hindus is unquestionable, an appeal is made to the theory of common origin and independent parallelism of growth.[1] These scholars seem to smart under a sense of injury if they have to con-

(1) Cf. "une affirmation nouvelle de l'unite de l'esprit humain. Chaque fois que l'homme au même degree de culture se retrouve dans le mêmes circonstances, il tend à penser, à croire, à sentir, à agir de la même façon."—Goblet d' Alviella on "Classical Influence in Literary and Scientific Culture in India"; "Bull. de l' Academie Royale de Belgique," 3rd Series, T. 34, pp. 484 et seq.

fess that Europe owes an intellectual debt to India, hence many a futile attempt to explain away positive historical facts.[1] It may not be superfluous to add here that Albérúní, before he took to the study of Sanskrit, enter-

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(1) In the mind of the average European this belief has taken too firm a hold to be easily eradicated. As Dr. Johnson observes :" "Modern writers are the moons of literature ; they shine with reflected light, with light borrowed from the ancients. Greece appears to me to be the fountain of knowledge."

Thanks, however, to the recent researches of orientalists, this notion is fast disappearing. The late Prof. Max Müller, who always held the balance evenly in deciding between the rival claims of the East and the West, in his last work, thus gives expression to the European sentiment : "In some respects, and particularly in respect to the greatest things........., India has as much to teach us as Greece and Rome, nay, I should say more. We must not forget, of course, that we are the direct intellectual heirs of the Greeks, and that our philosophical currency is taken from the capital left to us by them. Our palates are accustomed to the food which they have supplied to us from our very childhood, and hence whatever comes to us now from the thought-mines of India is generally put aside as merely curious or strange, whether in language, mythology, religion, or philosophy.—"Auld Lang Syne" : second series, p. 161. Elsewhere he says :

"Another excellent result which may, and I hope will, follow from our increased acquaintance with the actual thoughts and literature, as well as with the personalities of Oriental peoples, is a loosening of that prejudice which undoubtedly obtains, even

tained notions similar to those of Haas, d'Alviella and others, but after his intimate acquaintance with the literature of the Hindus he had to change or modify his views. We

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among scholarly circles, in the West.' It would be perhaps too much to complain that classical scholars, for instance, should have a decided repugnance to admit any actual influence on Greek thought or institutions as having been exercised by the thinkers of the East, however ungrudgingly that privilege is conceded to Egypt. Personally I think that they are quite in the right in maintaining that such an influence is, except in a few instances, at present entirely unproven. But surely there are many points of analogy which are most instructive, and suggestive at least of more than an analogical connection; points that may throw light upon the natural course of the evolution of human conceptions and, in doing so, help to throw light on dark corners of the history of that culture out of which our own has arisen. It is a common saying that it is impossible to know any one language well without at the same time knowing another, and I venture to think that a similar remark holds good of the history of religion or of ethics, or of institutions, or of philosophy."

"I know of men who could not construe a line of Sanskrit, and who speak and write of your ancient literature, religion, and philosophy as if they knew a great deal more than any of your best *Srotriyas*. How often you must have smiled on reading such books! The idea that anything could come from the East equal to European thought, or even superior, never enters the mind of these writers, and hence their utter inability to understand and appreciate what is really valuable in Oriental literature. There is no problem of philosophy and religion that has not

are here reminded of the essay written by Dugald Stewart "in which he endeavoured to prove that not only Sanskrit literature but also Sanskrit language was a forgery made by the crafty Brahma*n*s on the model of Greek after Alexander's conquest" (Macdonell).

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been a subject of deep and anxious thought among your ancient and modern thinkers. We in the West have done some good work too, and I do not write to depreciate the achievements of the Hellenic and Teutonic mind. But I know that on some of the highest problems of human thought the East has shed more light than the West, and by and by, depend on it, the West will have to acknowledge it. There is a very able article in the last number of the *Edinburgh Review* (Jan. 1881), on Dr. Caird's 'Philosophy of Religion.' Dr. Caird is a representative man in England, and more familiar than most Englishmen with the solid work of modern German philosophers. And what is the last result at which Dr. Caird arrives, and of which even the *Edinburgh Review* approves? Almost literally the same as the doctrine of the Upanishads! Dr. Caird writes: 'It is just in this renunciation of self that I truly gain myself; for whilst in one sense we give up self to live the universal and absolute life of reason, yet that to which we thus surrender ourselves is in reality our truer self.' And again: 'The knowledge and love of God is the giving up of all thoughts and feelings that belong to me as a mere individual self, and the identification of my thoughts and being with that which is above me, yet in me—the universal or absolute self, which is not mine or yours, but in which all intelligent beings

Those who attempt to prove* that India owes her civilisation—or at any rate such advance and progress in the arts and sciences which make civilisation worth the name—to Hellenic influence seem to be only one degree removed from a Dugald Stewart.

The analogy more superficial than real.

After all, we are afraid, too much has been made of the resemblance between the Greek and the Hindu theory and practice of medicine. The analogy is more superficial than real, and does not seem to bear a

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alike find the realisation and perfection of their nature' (p. 257). I need not tell you or any one who knows the Upanishads how powerfully the same doctrine, the doctrine of the Âtmâ and Paramâtmâ, was put forth by your old Rishis.

"Many years ago I ventured to show that the five-membered syllogism of the Indian Nyâya philosophy is the best form that can be given to the syllogism of inductive logic. But European logicians cannot get over the idea that there is no logic like that of our school-men, and that every deviation from it is a mistake.

"The same conceit runs through almost all that is written on India. India may be patronised, some works of Indian poets and philosophers may be called clever and curious, but to recognise in anything the superiority of Indian thought, or the wisdom of Indian native opinion, that is out of the question.

"Bio. Essays:" Letter to K. C. Sen.

close examination. The Hindu system is based upon the three humors of the air, the bile and the phlegm, whilst that of the Greek is founded upon four humors, namely, the blood, the bile, the water and the phlegm—a cardinal point of difference.[1]

Vágbhata.

Next to the Charaka and the Sus*r*uta, the medical authority, who is held in the highest estimation throughout India, is Vágbha*t*a, the author of As*t*áñgah*r*idaya (*lit.* heart or the kernel of the eight limbs or divisions of the Ayurveda). Indeed, in many parts of the Deccan the very names of Charaka and Sus*r*uta were forgotten, and Vágbha*t*a is looked up to as a *revealed* author, and this is one of the reasons which led Haas to conclude that the former succeeded, and owed their inspiration to, the

(1) Cf. "I'ly a dans le corps quatre humeurs : le sang, la bile, l'eau et le phlegme."—Œuvres d'Hippocrate, T. vii. p. 475. ed. Littré, (1851). Again : "Les quatre humeurs, sang, bile, phlegme et eau, j'ai démontré comment et pourquoi toutes s'augmentent dans le corps par les aliments et les boissons."—*Ibid*, p. 557.

latter' (see *ante* p. xxxiii).

The treatise of Vágbha*t*a may be regarded as an epitome of the Charaka and the Sus*r*uta with some gleanings from the works of Bhela and Hárita, and contains little or nothing that is original.[2] In Surgery alone the author introduces certain modifications and additions. Mineral and natural salts chiefly figure in the prescriptions along with vegetable drugs; mercury is incidentally mentioned, but in such a perfunctory manner that it would not be safe to conclude that any compounds thereof are referred to. There are, however, a few metallic preparations recommended in it, which would presuppose an advanced knowledge of chemical processes.

The opening salutation of Ash*t*áñga, which is addressed either to Buddha or some

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(1) "An die Stelle des seines Vorrange beraubten Sus*r*uta würde ich unbedenklich das Ash*t*ángah*r*idaya setzen."—Hippokrates und die indische Medizin des Mittelalters. Z.D.M.G., Vo 31, p. 649.

(2) See, however, *ante* p. xxix, foot note.

(3) Preface to Vaidyakas*r*abdasindhu. p. 6.

Buddhistic emblem, clearly reveals the religious faith of its author, there is a tradition current among the learned Pundits of S. India, "that Vágbhata, formerly a Brahmin, was persuaded by a Bauddha priest to adopt his religion, which he embraced in the latter part of his life."[1] Internal evidence also fully supports our author's proclivities towards Buddhism,[2] and he seems to have flourished

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(1) Preface to Vaidyakasabdasindhu. p. 6.

(2) See the numerous passages quoted by Dr. Kunte in his Introduction to Vágbhata, pp. 14-15.

The remarkable passage we have cited above, in which our author asserts the right every man to think for himself (p. xxix), is quite in keeping with the rationalistic age in which he lived, and he further observes in the same place that a medicine will have its efficacy all the same by whomsoever it is prescribed, be he Brahma himself or any body else. It should be commended to those who are lost in admiration over the "keen edged intellect" of *Samkara*, who does not find a better weapon to fight with his opponents than an appeal to the Vedas and other scriptures, see foot note to p. 195.

वाते पित्ते श्लेष्मशान्तौ च पथ्यं
तैलं सर्पिर्माक्षिकं च क्रमेण ।
एतद् ब्रह्मा भाषते ब्रह्मजो वा
का निर्मन्त्रे वक्तृभेदोक्तिशक्तिः ॥
अभिधातृवशात् किंवा द्रव्यशक्तिर्विशिष्यते ?

Uttara. XL. 85, 86.

at a time when the religion of *S*ákya Muni held its own in India. The Chinese pilgrim I'Tsing speaks of a compiler of the eight divisions of the Ayurveda—possibly this may refer to Vágbha*t*a.[1]

Cordier, following no doubt the authority of 'Vaidyaka*s*abdasindhu,' states that, according to Rájatarañginí, Vágbha*t*a lived at the time of King Jayasi*m*ha (1196-1218 A. D.); this view is quite untenable, and it is one of the many instances which would go to prove that Kalha*n*a in writing his Chronicles had often to draw largely upon vague traditions, and hence his dates are to be accepted *cum grano salis*.[2]

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(1) "These eight arts formerly existed in eight books, but lately a man epitomised them and made them into one bundle."—I'Tsing: "Records of the Buddhist Religion" by Takakasu, p. 128.

(2) The eminent Sanskrit scholar, the late A. M. Barua, in discussing the age of Kshirasvami discards the authority of *Rájtaranagini* and observes:—"I do hot see any valid reason for regarding it as a historical authority for all its statements and the more I learn the more my view is confirmed." The name of Vágbha*t*a, however, does not occur in Stein's edition of *Ráj.*, which may be pronounced as the most reliable that has yet appeared.

Csoma de Körös was the first to announce that the Thibetan Tanjur contains among others translations of the Charaka, the Susruta, and Vágbhata.[1] Georg Huth, who has recently critically examined the contents of the Tanjur, concludes that the most recent date at which it can be placed, is 8th century A. D.[2] This is in agreement with the fact that the Vágbhata was one of the medical works translated by order of the Caliphs. But no positive information as regards the most distant date is yet available;[3] Kunte, from internal evidence, is inclined to place him "at least as early as the second century before Christ."

Hindu Pharmacopœia in the 7th century.

That Hindu Pharmacopœia in the 7th century ran on the lines of the Charaka and the Susruta, and did not include any ela-

(1) Journ. Asiatic Soc. xxxvii. (1835).

(2) Zeit. deut morg. Ges, T. lxix, pp. 279-284.

(3) Regarding the bibliography of Vágbhata, see two short monographs by Dr. Palmyr Cordier; also Julius Jolly: "Zur Quellenkunde der indischen Medizin," I. 'Vágbhata, Zeit. deut. Morg. Ges. LIV. pp. 260-74.

borate metallic preparations is evident from the testimonies of Váṇa and of the Chinese pilgrim, I-Tsing. Thus, we read in the Harsha-Charita: "among their number, however, was a young doctor of Punarvasu's race named Rasáyana, a youth of about eighteen years of age, holding an hereditary position in the royal household, in which he had been cherished like a son by the King. He had mastered Ayurveda in all its eight divisions, and, being naturally of an acute intellect, was perfectly familiar with the diagnosis of diseases:"[1] I-Tsing also records: "I made a successful study in medical science, but as it is not my proper vocation, I have finally given it up."[2] In his rules on giving medicine he further lays stress on abstinence and fasting and recommends such drugs as the myrobalans, ginger, pepper, liquorice, etc.

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(1) Cowell and Thomas' Trans. pp. 143-144.

(2) Takakasu: "Records of the the Buddhist Religion," p, 128.

In both instances, in vain do we look for any metallic salts, which form the leading features of the later Tantric and Iatro-Chemical Schools.[1]

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(1) See, however, below under the marginal heading : "The age of the Tantras dealing with mercury."

CHAPTER III

The Transitional Period

Circa 800—1100 A. D.

VRINDA AND CHAKRAPANI

We now come upon a period which determines the parting of ways in the progress of Hindu medicine. Hitherto we have been chiefly concerned with herbs and simples and a few readily available products of the mineral kingdom. About the year 1050 A. D. Chakrapáni Datta, himself a learned commentator of both the Charaka and Susruta, wrote the celebrated medical treatise which bears his name. Since the days of Vagbhata, metallic preparations had begun slowly to creep into use, and at the time of Chakrapáni and his predecessor Vrinda, they had so fully established their claims that they could no longer be ignored. Thus we find from

the tenth century and downward every medical work more or less recommending compounds of metals which can only be synthetically prepared.

It should not, however, be forgotten that Sus*r*uta at times shows a knowledge of pharmacy, unsurpassed in the later Hindu medicine.

Although Chakrapá*n*i belonged to the Brahmanical creed, his writings show a decided leaning towards Buddhism. Thus Maghadha itself is named **महाबोधिप्रदेश** or the country of the Mahábodhi ; we have also such expressions as **बोधिसत्त्वेनभाषितं, सुखावती वर्त्तिं, सौगतमञ्जनम्** । This might well be expected, for Chakrapá*n*i's father was physician to king Nayapála, the successor of Mahipála, who ascended the throne about 1040 A.D.[1]

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(1) The author, fortunately for future historians, has given an account of himself in a colophon :—

गौड़ाधिनाथरसवत्यधिकारिपात्र-

नारायणस्य तनयः सुनयोऽन्तरङ्गात् ।

Both V*ri*nda and Chakrap*á*n*i* mention Nágárjuna as an authority, and they follow closely in the footsteps of Charaka, Sus*r*uta and Vágbha*t*a ; but at the same time they are amenable to the influences brought to bear upon medicine by the Tantras.

Indeed, they go so far as to recommend the uttering of the cabalistic interjections of the votaries of the Tantric cult with a view to increase the efficacy of some of their preparations.[1] (see *ante* p. i.)

Dr. Hoernle observes : "it would be satisfactory to be able to discover what

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भानोरनु प्रथितलोध्रवली कुलीनः
श्रीचक्रपाणिरिह कर्तृपदाधिकारी ॥

"The author of this work is *S*ri C. P., who belongs to the family of Lodhrávali and who is younger brother of Bhánu and the son of Náráyana, the superintendent of the kitchen of the King of Gour." Regarding the date of Nayapála, *vide* Cunningham's "Archaeological Survey of India," III. p. 119, also Journ. As. Soc. LX. Pt. 1. p., 46, Life of Atisa by S. C. Dása.

(1) अयं मन्त्रः प्रयोक्तव्यो भिषजा चाभिमन्त्रणे ।
ओं नमो विनायकाय अमृतं रक्ष रक्ष मम फलसिद्धिं
देहि देहि रुद्रवचनेन स्वाहा ॥१७ इन्द्ररसायनाधिकारः ।

Poona ed. p. 518.

the sources were on which Chakrapá*n*i drew for his compilation ; they are not specified anywhere, I believe, in his work." [1] It is not easy to account for the above remarks, seeing that Chakrapá*n*i distinctly mentions that he has modelled his work on the Siddhayoga of V*ri*nda, [2] and that he draws largely upon the Charaka, the Su*s*ruta and the Vágbha*t*a, all of whom he quotes verbatim and at length.

The religion of *S*ákyamuni inculcates the alleviation of distress and suffering, both moral and physical, as one of the essential articles of faith, and hence we find throughout

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"इदमिह दृष्टोपकारमेतद्दृष्टेन मन्त्रेण ।
स्नातान्तेन विमर्दो भवति फलेन सोऽप्यनलरक्षा ।
सनमस्कारेण च गर्भवत्यमयमी दृष्टेन ॥
"ओं" अमृतोद्भवाय स्वाहा ।" "ओं" अमृते हूं फट् ।"
"ओं" नमश्चण्डवज्रपाणये महायक्षसेनाधिपतये सुरगुरुविद्या-
महाबलाय स्वाहा ।" "ओं" अमृते हूं । इति चक्रपाणि-
रसायनाधिकारः ।

(1) Journ. As. Soc. Beng. LX. pt. 1. p. 150.

(2) यः सिद्धयोगलिखिताधिकसिद्धयोगा-
नत्रैव निक्षिपति केवलमुद्धरेद्वा ।

Buddhistic India hospitals attached to the numerous monasteries for the treatment of man and beast alike.[1] It would also appear that inscriptions were engraved on rock pillars giving recipes for the treatment of diseases. Thus both V*r*inda and Chakrapá*n*i speak of a formula for a collyrium as inscribed on a stone pillar by Nágárjuna at Pátaliputra : नागार्ज्जुनेन लिखिता स्तम्भे पाटलिपुत्त्रके ।

Probable date of V*r*inda.

Chakrapá*n*i bases his work on that of V*r*inda, who again follows closely the order and the pathology of the Nidána of Mádhavkara.[2] It necessarily follows that V*r*inda was a recognised authority at least one or two centuries before the time of Chakrapá*n*i and that the former was preceded by the Nidána by at least as many centuries and thus we have internal evidence of the exis-

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(1) "Everywhere the King Piyadasi, beloved of the Gods, has provided medicines of two sorts, medicines for men and meidicines for animals." Edict II. of Aroka.

(2) V*r*inda himself admits this :

वृन्देन * * * संलिख्यते गदविनिश्चयक्रमेण ॥

tence of the Nidána in the eighth century as the lowermost limit—a date which is further corroborated by the fact that the Nidána was one of the medical treatises translated by order of the Caliphs.

Alchemy in the eleventh century.

As regards alchemy in India in the XIth century, we cannot do better than quote *in extenso* Alběrúní, who was well versed in Arabic and Greek astronomy, chemistry etc.

" The Hindus do not pay particular attention to alchemy, but no nation is entirely free from it, and one nation has more bias for it than another, which must not be construed as proving intelligence or ignorance ; for we find that many intelligent people are entirely given to alchemy, whilst ignorant people ridicule the art and its adepts. Those intelligent people, though exulting boisterously over their make-believe science, are not to be blamed for occupying themselves with alchemy, for their motive is simply excessive eagerness for acquiring fortune and for avoiding misfortune. Once a sage was asked why scholars always flock to the doors of the rich, whilst the rich are not inclined to call at the doors of scholars. 'The scholars,' he

answered, 'are well aware of the use of money, but the rich are ignorant of the nobility of science.' On the other hand, ignorant people are not to be praised, although they behave quite quietly, simply because they abstain from alchemy, for their motives are objectionable ones, rather practical result of innate ignorance and stupidity than anything else.

"The adepts in this art try to keep it concealed, and shrink back from intercourse with those who do not belong to them. Therefore, I have not been able to learn from the Hindus which methods they follow in this science and what element they principally use, whether a mineral or an animal or a vegetable one. I only heard them speaking of the process of *sublimation*, of *calcination*, of *analysis*, and of the *waxing of talc*, which they call in their language "tālaka," and so I guess that they incline towards the minerological method of alchemy.

"They have a science similar to alchemy which is quite peculiar to them. They call it *Rasāyana*, a word composed with *rasa i.e.* gold.[1] It means an art which is restricted to certain operations, drugs, and compound medicines, most of which

(1) See, however, p. 79. for the meaning of the term ,'rasa"

are taken from plants. Its principles restore the health of those who were ill beyond hope, and give back youth to fading old age, so that people become again what they were in the age near puberty; white hair becomes black again, the keenness of the senses is restored as well as the capacity for juvenile agility, and even for cohabitation, and the life of the people in this world is even extended to a long period. And why not? Have we not already mentioned on the authority of Patañjali that one of the methods leading to liberation is Rasāyana? What man would hear this, being inclined to take it for truth, and not dart off into foolish joy and not honour the master of such a wonderful art by popping the choicest bit of this meal into his mouth?" Sachau's Trans. Vol. I. pp. 187-88.

CHAPTER IV

The Tantric Period

Circa 1100 A.D.—1300 A.D.

Origin of the Tantric Cult.

Before we proceed further it would be advisable to take a hasty glance at the origin of the Tantric Cult, as Indian Alchemy very largely derives its colour and flavour from it. In almost every country the progress of chemistry can be traced to medicine and the belief in the artificial gold-making,—the search after *elixir vitæ* and the philosopher's stone. In India, however, these ends have played a secondary part in promoting a knowledge of the chemical processes. Here the origin of astronomy, geometry and anatomy is to be sought in the exigencies of religious rites.[1] No less

(1) Cf. the opening remarks by Dr. Thibaut on the "Sulva-sûtras":—

is the case with alchemy. We have already seen how the Atharva-veda deals almost exclusively in charms, sorcery, exorcism of diseases by means of amulets and so on. It is sometimes supposed that the A.V. represents the latest of the Vedas. This is evidently a misimpression.[1] The truth seems to be that human frailty has always fought shy of the tedious and laborious methods of gaining an object. The spiritual hankering as foreshadowed in the prayers of the *Rik*, and later on so fully developed

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"It is well kuown that not only Indian life with all its social and political institutions has been at all times under the mighty sway of religion, but that we are also led back to religious belief and worship when we try to account for the origin of research in those departments of knowledge which the Indians have cultivated with such remarkable success. At first sight, few traces of this origin may be visible in the *Sástras* of the later times, but looking closer we may always discern the connecting thread."—"Journ. As. Soc." (1875) Vol. XLIV. part 1. p. 227.

(1) As Bloomfield remarks:—There is no proof that even the oldest parts of the *R. V*. or the most ancient Hindu tradition accessible historically, exclude the existence of the class of writings entitled to any of the names given to the Atharvan charms.' Intro. to A. V. X. pXX.

in the Upanishads, represents only the aspirations of the few cultured *R*ishis. The bulk of the people have always sighed for a royal road to salvation, hence the necessity for an A.V.; as Emerson appositely says in his essay on Demonology, "the history of man is a series of conspiracies to win from Nature some advantage without paying for it." Atharvanic rites have therefore more or less held sway over mankind in every age and clime. As the Aryan conquerors began to settle in India and came into frequent contact with the aborigines, they had unconsciously to imbibe some of the gross superstitions of the latter, and thus in course of time a superstructure of monstrous growth sprang up, ready to swallow even the purer and more othodox creed. Hence the protests recorded from time to time in the Mahábhárata and in the law-books against the vulgarity of the aims of the A. V. and the refusal to accept its authority (see *ante* p. viii). But on the other hand, by virtue of its profound hold

upon popular beliefs and because indispensable sciences like medicine and astrology are Atharvanic by distiction, the fourth Veda has always retained a considerable following.[1] If we turn to Europe in the middle ages, we find the professors of the "black art" sharing a fate similar to the priests of the Atharvanic rites,——now openly received into the bosom of the holy church——now anathematised and flung into prison.[2]

In the Sanskrit Literature whenever there is any reference to sorcery or magic, it is generally laid to the account of the A. V. But in the course of time the worship of *S*iva came into vogue, which incorporated much that was non-Aryan in character, and which seems to have got blended with A. V.

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(1) Bloomfield:—Intro. to *A. V.* xlvi.

(2) This is exemplified in Albertus Magnus and Roger Bacon. The former rose to be a Bishop but "minder glücklich oder unvorsichtiger als Albertus Magnus, entging Roger Baco der Verfolgung als Zauberer nicht. Er wurde in Oxford von seinen eigenen Klosterbrüdern in das Gefängniss geworfen."—"Gesch. d. Chem." 1. 63.

rites as modified by changes and requirements of the time. The original inhabitants, "the Dasyus are described in the *Rig*veda as non-sacrificing, unbelieving and impious. They are also doubtless meant by the phallus-worshippers mentioned in two passages. The Aryans in course of time came to adopt this form of cult. There are many passages in the Mahábhárata showing that *S*iva was already venerated under the emblem of the phallus when that epic was composed."[1]

Tantric rites prevalent in the seventh century.

By the VIIth century A. D., we find *S*iva's worship well established in India. In the life of King Harsa by Vá*n*a there is a graphic description of a weird ceremony performed by a *S*aiva saint named Bhairavácháryya. "Seated on the breast of a corpse which lay supine, anointed with red sandal and arrayed in garlands, clothes and ornaments, all of red, himself with a black turban, black unguents, black amulet, and black garments, he had

(1) Macdonell : "Hist. Sansk. Lit". p. 153.

begun a fire rite in the corpse's mouth where a flame was burning."[1] In the drama of Málatímádhava by Bhavabhúti (690 A.D.) we have also references to similar rites.

We have here the outlines of what has been known latterly as the Tantric Cult—a curious admixture of alchemical processes on the one hand, and grotesque and obscene and sometimes revolting rites on the other—all centred round the worship of *S*iva and his consort Párvatí. The sidelight which is thrown in the life of King Harsa and the graphic account left by his contemporary, the Chinese pilgrim Hiuen Thsang, enable us to draw a picture of N. India in the VIIth century A.D. It has hitherto been taken almost for granted that Buddhism was expelled from India by the persecution of the Brahmins of the Renaissance period. There may have been zealous bigots who now and then went the length of hunting down Buddhists ; but the concensus of testimonies seems to be that both the

(1) Cowell and Thomas' "Trans. of the Harsa-charita p. 92."

people and the princes generally maintained an attitude of philosophic toleration towards the creed of Sákyamuni even so late as the XIth century A.D.[1] The causes which brought about the extinction of Buddhism in India worked from *within*. The purity of life, and the austerity of practices enjoined on the followers of the creed, become in the long run irksome.

The causes which brought about the extinction

(1) Cf. 'The annual report of the Asiatic Soc. to hand :—

"The copper-plate of Madanapála which has just been referred to is interesting also from a sociological point of view. We know that all the Pála kings were followers of the Buddhist religion, and that it was during their reign that Buddhism flourished for the last time in India. Now the grant recorded in the plate was made by Madanapála to a Brahman as a *dakshina* or honorarium for having read the Mahábhárata to the queens of the king's harem. This is one more fact, in addition to others previously known, showing the intimate connexion that existed in the time of those Buddhist kings between Buddhism and Hinduism, a connexion that resulted in the former losing more and more its ground against the latter, and that thus prepared the way for the final destruction of Buddhism by the Muhammedan invadors." p. 26. Similar evidence is also afforded by Raj. Tar. *e.g.*

"Kalhana does not hesitate to refer repeatedly to the Bodhisattvas or to Buddha himself as the comforters of all beings, the embodiments of perfect charity and nobility of feeling. They are to him beings of absolute goodness "who do not feel anger even

The monasteries degenerated into hot beds of corruption, so much so that the semi-savage Mussulman conquerors felt little compunction in putting the inmates thereof to the sword. [1] Hinduism also, which has been noted in all ages for its assimilative and elastic character, swallowed up the remnants of the Buddhists by acknowledging the founder of their religion to be an *Avatāra* or Incarnation of Vishṇu.

of Buddhism.

We have seen that the A.V. rites as also the Tantric cults cover almost identical ground; both had their origin in the attempts at popularising the religion among the masses by appealing to the baser or the less refined elements of human nature. An enormous bulky literature has thus sprung up representing this corrupt and effete outgrowth of

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against the sinner, but in patience render him kindness,,—Stein's Intro. p. 8.

(1) According to Waddell, the monks with shaven heads were mistaken for idolatrous Brahmins and massacred wholesale. "Journ. As Soc." LXI. pt. 1, p. 20.

Brahminism.[1] There are however two distinct classes of Tantras—Brahminic and Buddhistic—dealing in magic, alchemy, sorcery, and allied subjects, which will claim our attention here. The causes which favoured the rise and progress of the Hindu Tantras equally contributed to the development of the Buddhistic,[2] only in the latter, instead of *S*iva and Párvatí, a Buddha, a Tathágata or an Avalokitesvara is often addressed in the invocation as the source and fountain of all knowledge. We have also a class of Tantras which is an admixture of Buddhistic and *S*aiva cult. A notable example of which is afforded by the

Tantras—Brahminic and Buddhistic

(1) Tantras grew up in Kásmír also: "Tantric cult which in Kásmír is still closely connected with *S*aiva worship, seems also to have been well known to Kalhana." Stein's Intro. to Raj. Tar p. 80.

(2) Cf. "Pour des esprits grossiers et ignorants, de tels livres ont certainement plus de valeur que les légendes morales des premiers temps du Buddhisme. Ils promettent des avantages temporels et immédiats; ils satisfont enfin à ce besoin de superstitions, à cet amour des practiques dévotes par lequel s'exprime le sentiment religieux en Asie, et auquel ne répondait qu'imparfaitement la simplicité du Buddhisme primitif." Burnouf's

Mahákála Tantra.[1] Rasaratnákara, the authorship of which is ascribed to Nágárjuna, also belongs to this category; this work as well as Rasárnava, a Tantra of the Saiva cult, will claim our special attention, as they embody much valuable information on chemistry.

What is it that made these Tantras the repositories of chemical knowledge? The answer is given in the words of Rasárnava (lit. sea of mercury) itself, which extols the virtues of mercury and its various preparations:—

"As it is used by the best devotees for the highest end, it is called *pārada* (quicksilver)."

"Begotten of my limbs, it is, O goddess, equal to me. It is called *rasa* because it is the exudation of my body."

"It may be urged that the literal interpretation of these words is incorrect, the liberation in this life being explicable in another manner. This

—"Intro a l'hist. du Buddhisme Ind." p. 466. Regarding Buddhistic Tantras and their relationship to Saiva Tantras, the reader is referred to Burnouf's admirable exposition (loc. cit). See also Barth's. "Religions of India." p. 201, 3rd ed.

(1) Intro. Hist. Buddh. Ind., p. 480.

objection is not allowable, liberation being set out in the six systems as subsequent to the death of the body, and upon this there can be no reliance, and consequently no activity to attain to it free from misgivings. This is also laid down in the same treatise.

"Liberation is declared in the six systems to follow the death of the body."

"Such liberation is not cognised in perception like an emblic myrobalan fruit in hand."

"Therefore a man should preserve that body by means of mercury and of medicaments."

A few more typical extracts are given below which will throw further light on the subject :

"The body, some one may say, is seen to be perishable, how can then its permanency be effected? Think not so, it is replied, for though the body, as a complexus of six sheaths or wrappers of the soul, is dissoluble, yet the body as created by Hara and Gauri under the names of mercury and mica, may be perdurable. Thus it is said in the Rasah*ri*daya :—

"Those who without quitting their bodies have attained to new ones through the influence of Hara and Gouri (mercury and mica), are to be praised as *Rasasiddha* (alchemists). All *mantras* are at their services."

"The ascetic, therefore, who aspires to liberation in this life, should first make to himself a glorified body. And inasmuch as mercury is produced by the creative conjunction of Hara and Gaurí, and mica is produced from Gaurí, mercury and mica are severally identified with Hara and Gaurí in the verse :—

"Mica is thy seed, and mercury is my seed ;

"The combination of the two, O goddess, is destructive of death and poverty."

"There is very little to say about the matter. In the Rasesvarasiddhánta many among the gods, the Daityas, the Munis and mankind, are declared to have attained to liberation in this life by acquiring a divine body through the efficacy of quicksilver."

"Certain gods, Mahesa and others ; certain Daityas, Kāvya (Sukrāchārya), and others ; certain sages, Bālakhilyas and others ; certain kings, Somesvara and others ; Govinda-Bhāgavat, Govindanáyaka, Charvati, Kapila, Vyāli and others—these alchemists, having attained to mercurial bodies and therewith identified are liberated though alive."

"The meaning of this, as unfolded by

Siva to Párvatí, is as follows :—

"The preservation of body, O Supreme goddess! is obtained by mercury and by (the suppression of) breath.[1] Mercury, when swooned, cures diseases and when killed, restores life to the dead. Mercury and air when confined, enable a man, O goddess, to fly about.

"The *swooning state* of mercury is thus described :—

"They say quicksilver to be swooning when it is thus characterised.—

"Of various colours, and free from excessive fluidity or mobility (see p. 74).

"A man should regard that quicksilver as dead, in which the absence of the following properties is noticed.—

"Wetness, thickness, brightness, heaviness, mobility.

"The *fixed* condition is described in another place as follows :—

"The character of fixed quicksilver is that it is:—

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(1) Here Cowell and Gough translate पवन simply as "air' We are inclined to think, however, that it is used in the sense of *closing the nostrils*—प्राणायाम of Yoga philosophy.

"Continuous, readily fusible, efficacious, pure, heavy, and that it can revert to its own natural state." Cf. p. 247.

"Some one may urge: If the creation of mercury by Hara and Gaurí were proved, it might be allowed that the body could be made permanent; but how can that be proved? The objection is not allowable, inasmuch as that *can* be proved by eighteen modes of elaboration. "Thus it is stated by authorities.—

"Eighteen modes of elaboration are to be carefully discriminated."

"In the first place, as pure in every process, for perfecting the adepts."

And these methods of elaboration are enumerated thus.—

"Sweating, rubbing, swooning, fixing, dropping, coercion, restraining."

"Kindling, going, falling into globules, pulverising, covering."

"Internal flux, external flux, burning, colouring, and pouring."

"And eating it by parting and piercing it — are the eighteen modes of treating quicksilver."

"These treatments have been described at length by Govinda-Bhágavat, Sarvajña-rámesvara and the other ancient authorities, and are here omitted to avoid prolixity.

"By the science of mercury is to be understood not only a branch of chemistry alone, but it is also to be applied to salvation by means of *dehavedha*. Rasárnava says.—

"You have, O God, explained the killing of metals. Now tell me that process of *dehavedha* by means of which ærial locomotion is effected. Mercury is equally to be applied to metals and body. First make its experiment on metals and then [having thus gained experience] apply it to the body."[1]

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(1) We have in some places adopted Cowell and Gough's trans. of Sarvadarsanasamgraha, but the rendering appears to be faulty in many instances, notably in the above sloka. The original runs as follows :—

न च रसशास्त्रं धातुवादार्थमेवेति मन्तव्यं देहवेधद्वारा मुक्तेरेव परम-प्रयोजनत्वात्। तदुक्तं रसार्णवे

लोहवेधस्त्वया देव यदुक्तः परमोज्झितः।
तं देहवेधमाचक्ष्व येन स्यात् खेचरी गतिः॥
यथा लोहे तथा देहे कर्तव्यः सूतकः सदा।

Emancipation of a man when alive, as declared in the mercurial system, O subtile Thinker ! is (to be found) in the tenets of other schools though holding different methods of arguments. It is according to all sacred texts to be known by knowledge. None, when not alive, is likely to know the knowable and therefore a man must live (to know the knowable)."

"It is mercury alone that can make the body undecaying and immortal, as it is said :—

"Only this supreme medicament can make the body undecaying and imperishable."

"Why describe the efficacy of this metal? Its value is proved even by seeing it, and by touching it, as it is said in the Rasár*n*ava :—

"By means of seeing it, touching it, eating it, remembering it, worshipping it and bestowing it

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समानं कुरुते देवि प्रत्ययं देहलोहयोः ।

पूर्वं लोहे परीक्षेत पश्चाद्देहे प्रयोजयेदिति ॥

I. C. Vidyáságar's Ed. (1858).

Here Cowell and Gough render धातुवादार्थे as "eulogistic of the metal;" and लोह as "blood." Regarding धातुवादः See p. 191.

npou others, six k inds of highest merits are attained.

"Equal merit accrues from seeing mercury as accrues from seeing all the phallic emblems."

"On earth, those at Kedāra, and all others whatsoever."

"In another place we read :—

"The adoration of the sacred quicksilver is more beatific than the worship of all the phallic emblems at Kási and elsewhere."

"Inasmuch as there is attained thereby enjoyment, health, exemption from decay, and immortality."

"The sin of disparaging mercury is also set out :—

"The adept on hearing quicksilver heedlessly disparaged should recall quicksilver to mind."

"He should at once shun the blasphemer, who is by his blasphemy for ever filled with sin." Cf. under R. R. S. p. 78.

The quotations given above are from the "Sarvadarsanasamgraha," or a "Review of the different systems of Hindu Philosophy" by Mádhavácharya, prime minister to Bukka I. of Vijayanagara, and who was elected in 1331 A. D. head-abbot of the monastery

of Sringeri. Of the sixteen philosophical systems current in the 14th century during the author's lifetime, Rasesvaradarsana or the "Mercurial System," is one. From the fact that Rasárnva is quoted in it as a standard work on this subject it would be safe to conclude that it must have been written at least a century or two earlier, say sometime about the 12th century. In Amarasimha's Lexicon (ca. 1000 A. D.)[1] the following synonyms of *párada* (mercury) are given, namely, *chapala*, *rasa*, and *suta*; but in the vocabulary of Visvakosha by Mahesvara (1188 A. D.) haravíja (lit. semen of Siva) is added thereto. Now in the Tantric literature, of which the philosophy of mercury is the main outcome, quicksilver is regarded as the generative principle, and directions are given for making a mercurial phallus of Siva. We may, therefore, take it that the Tantras which deal in mercurial preparations, had their origin sometime about the

(1) Regarding the date of Amarsimha see also p. 146.

11th to 12th century A. D. It whould not be justifiable however to hold that the Tantras did not exist before this time.

The age of the Tantras, dealing with mercury.

Although we have maintained above that the alchemical Tantras had their origin about the 11th century A. D., it would be safer to conclude that the Tantric processes had sprung into existence long before this time, but that they did not acquire sufficient importance to force the attention of the physicians, as we have seen above that the R. V. and the A. V. existed almost side by side though the latter was held for a long time in contempt and was not quoted in the orthodox treatises.

One very strong argument in favour of much older dates of the above Tantras is that Mádhavácharya, a very cautious and discriminating writer, whom we have quoted above, describes the works he cites, including Rasár*n*ava, as "ancient authorities" in his

life-time (see above p. lxxvi).[1]

We have already had occasion to draw attention to the non-mention of metallic preparations, notably of those of mercury, in the writings of Vá*n*a and I'Tsing (p. li). But this is another apt illustration of the dangers of the *argumentum ex silentio*. In the V*ri*hatsa*m*hitá of Varáhamihira (d. 587 A. D.) there is mention of iron and mercury among the aphrodisiacs and tonics;[2] and this his-

Earliest historical evidence of the internal use of mercury.

(1) A recent examination of the Sanskrit Mss. in the Durbar Library of Nepal has brought to light important old Tantric works. One, the Lamkávatára, a Hindu Tantric work on medicine, written in a later Gupta hand (908 A. D.); another, "the composition of which must go back to the early centuries of the Christian era." This discovery upsets all established theories as to the age of the Tantras, a full discussion of which must be reserved for the second volume *Vide.*—Rep. on the Search of Sans. Mss. (1895-1900) by M. H. P. *S*ástri.

(2) रक्तेऽधिके स्त्री पुरुषस्तु शुक्रे नपुंसकं शोणितशुक्रसाम्ये ।
यस्मादतः शुक्रविवृद्धिदानि निषेवितव्यानि रसायनानि ॥ १ ॥
माक्षीकधातुमधुपारदलोहचूर्ण-
पथ्याशिलाजतुविडङ्गघृतानि योऽद्यात् ।
सैकानि विंशतिरहानि जरान्वितोऽपि
सोऽशीतिकोऽपि रमयत्यबलां युवेव ॥ २ ॥

torical evidence is of great use to us in deciding the age of the Tantras, dealing with mercury.

Contemporary collateral records by foreign writers go to corroborate the date of the alchemical Tantras tentatively fixed by us, as the name and fame of mercurial remedies as used by the Hindu *yogis* had spread far and wide. The following two extracts will suffice:

"There is another class of people called *Chughi* (yogi), who were indeed properly Abraiman, but they form a religious order devoted to the idols. They are extremely long-lived, every one of them living to 150 or 200 years. They eat very little * * * and these people make use of a strange beverage, for they make a potion of sulphur and quicksilver mixed together, and this they drink twice every month. This, they say, gives them long life: it is a potion they are used to take from their childhood."—Yule's "Macro Polo," Vol. II. p. 300.

"Arghun, der alchymie und den geheimen Wissenschaften ergeben hatte indische Bachschi, d. h. Schreiber, gefragt, durch welche Mittel sie

sich ihr Leben so langwierig fristeten. Sie gaben ihm ein aus Schwefel und Merkur zusammengesetztes Mittel als die Panacee der Lebensverlängerung ein." (1290 A. D.)—Hammer-Purgstall; "Geschichte der Ilchane," I. p. 391.

Alchemical Tantras.

It is to be regretted that of the several works quoted by Mádhava, Rasár*n*ava alone seems to have survived to our days. This work is almost unknown in Bengal, and extremely rare even in N. India and the Deccan. We have been fortunate enough to procure a transcript of it from the Raghunátha Temple Library, Kásmír, and another from the Oriental Mss. Library, Madras. As one of the earliest works of the kind, which throws a flood of light on the chemical knowledge of the Hindus about the 12th century A. D., Rasár*n*ava must be regarded as a valuable national legacy. It has, besides, the merit of being the inspirer of several works of the Iatro-chemical period, notably Rasaratnasamuchchaya and Rasendrachintáma*n*i. Although Rasár*n*ava as a Tantra prefers to

have been revealed by the God *S*iva himself, its author, whoever he may be, now and then blurts out hints, which clearly prove it to have been complied from preëxisting works, for instance, it has not hesitated, as we find; to borrow copiously from Rasaratnákara attributed to the renowned alchemist Nágárjuna. Of this last work we have been able to obtain as yet only a fragment from the Kás*m*ír Library; but it has been of signal use to us, as by the parallelism of its text the genuiness and authenticity of a great portion of the Rasár*n*ava have been established.

Collation of Mss.

In the present volume it has been our aim to compare and collate carefully the passages in the Mss. of Rasaratnákara, Rasár*n*ava and Rasatnasamuchchaya, in so far as they bear on chemistry and allied subjects; in this way several important lacunæ have been filled up and many doubtful readings resored. Parallel passages have often been quoted in the foot-notes and cross-

references given, pointing out where the probable borrowing has taken place. It is to be hoped that by instituting this sort of intercomparison, the verbal integrity of the texts adopted may be depended upon, and the danger of interpolation has been avoided. The texts of Charaka, Susruta, Vágbhaṭa and Chakrapáṇi have not been reproduced as they are available everywhere in the most reliable shape.

Recommendatory features of R. R. S.

The translations presented do not always pretend to be strictly literal, and we hope the indulgent reader will put up with infelicities of expression here and there, which could not be avoided without taking undue liberty with the original. We have drawn very largely upon R. R. S., because it has several features to recommend. First, an excellent edition of it has been published at Puna, based upon a comparison of 13 Mss., procured from different parts of Southern India. Second, there exists a Ms. of it in the library of the Sanskṛit College, Benares, in a very neat and

legible handwriting, copied in samvat 1850 i. e. 1793 A.D., to which we have had access whenever required. We have also obtained a transcript of it from the Kásmír Library. The Benares and the Kásmír Mss. agree in all essentials, but differ in certain places from the Puna edition. The text we have adopted is thus based upon a comparison of the Deccanese and N. Indian exemplars. Third, while Rasaratnákara and Rasárnava are Tantras pure and simple in which alchemy is incidentally dwelt upon, R. R. S. is a systematic and comprehensive treatise on materia medica, pharmacy and medicine. Its methodical and scientific arrangement of the subject-matter would do credit to any modern work, and altogether it should be pronounced a production unique of its kind in Sanskrit literature. Its value is further enhanced from the fact that the materia medica portion is harmoniously blended with chemistry.

pseudo-Vágbhata.

The author, whoever he may be, is very anxious to establish his identity with Vágbhata,

the celebrated author of the Ash/áñga and describes himself as such in the colophons at the end of every chapter (p. 78); but he forgets that in doing so he is guilty of a glaring piece of anachronism. The chemical knowledge, as revealed in the Vágbha/a, is almost on a par with that in the Susruta. But this sort of utter disregard for chronological accuracy is by no means uncommon in the alchemical literature of the middle ages in Europe. The world is indebted to the genius and perseverance of M. Berthelot for unravelling the mysteries which so long hung about the writings of Geber[1]; and the interval of time between our pseudo-Vágbha/a and the author of Ash/áñga is even much wider than that between the Latin Geber and the real Geber. We are apt to be very harsh

1)) "L'hypothèse la plus vraisemblable à mes yeux, c'est qu'un auteur latin, resté inconnu, a écrit ce livre dans la seconde moitié du XIIIe siècle, et l'a mis sous le patronage du nom vénéré de Géuer; de même que les alchimistes gréco-égyptiens avaient emprunté le grand nom de Démocrite pour en couvrir leurs élucubrations."—"La Chimie au Moyen Âge, T. 1. p. 349

on these literary forgerers; rather we ought to give them credit for their utter self-effacement. We often forget that the spirit of the times in which they wrote was dead against them—reluctant to accept revolutionary ideas or discoveries; hence the temptation to fasten them on old and recognised authorities.

Although no direct historical evidence is available, we are not left entirely in the dark. Our author, at the very outset, names twenty seven alchemists from whose writings he derives his materials (p.77), and later on, in the section on apparatus (p. 130), he quotes Rasárnava as a source of his information. Opium was not employed in medicine in his time nor is there any mention of Phiraṅgaroga, (lit. the disease of the Portuguese),[1] which was introduced into India about the middle of the 16th century, and the treatment of which by means of calomel and *chob-chini*

Probable date of R. R. S.

(1) This is the name by which syphilis is known in the later Hindu medical works. See p. 252.

(China root) occupies a conspicuous place in in the much later work, Bhávaprakása. The date of the R. R. S. may, therefore, be placed between the 13th and 14th centuries A. D.

CHAPTER V

Iatro-Chemical Period

Characterstics of the intro-chemical period

During the Tantric period, with its system of the "Philosophy of Mercury" a vast mass of chemical information was accumulated, which was pressed into signal service in the period immidiately succeeding it—the Iatro-chemical Period of India. The prominent feature of the former lies in the search after the *elixir vitae* and the powder of projection as the contents of the Rasaratnákara and Rasárnava amply testify; whereas in the latter these phantastic and extravagant ideas, impossible of realisation, had subsided into something more practical and tangible. The numerous preparations of mercury, iron, copper and other metals, although they could not secure immortality or revive the dead, were found to be helpful accessories in medicine. At first they came

to be used cautiously and tentatively, mixed up with the recipes of the Charaka and the Su*s*ruta, which are drawn chiefly from the vegetable kingdom; but they soon began to assert a supremacy of their own and even to supplant the old Ayurvedic treatment by herbs and simples. Nay more, absurd pretentions were set up on behalf of these metallic preparations. Thus in Rasendrachintáma*n*i, a work probably co-eval with R. R. S., we come across this remarkable passage:—"Revered teacher! be pleased to instruct me, for the benefit of the weak and the timid, in a mode of treatment which will dispense with the use of the lancet, and both active and potential cauteries," thus putting in a plea for the indiscriminate use of mercurial remedies.

R. R. S. is a typical production of the Iatro-chemical period. The name of treatises treating of medicinal chemistry is simply legion. But they are all cast in the same mould, and the close similarity of their contents would render their translation only a

works of supererogation. We have, therefore, confined ourselves to quoting only such parallel passages in the foot-notes as are calculated to throw light upon or corroborate the authenticity of, the text of R. R. S.

Nágárjuna.

An account of this period will be scarcely complete, which fails to take note of the conspicuous figure whom the Indian alchemists unanimously look upon as the inventor of the processes of distillation and calcination—the renowned and the venerable Nágárjuna, the reputed author of Kakshaputatantra, Rasaratnákara and Arogyamañjarí, etc. Our R. R. S., in the opening lines, invokes him as one of the 27 alchemists, and in the chapter on minerals quotes him as an authority. So does Rasendrachintáma*n*i as also Chakrapá*n*i while describing the process of roasting iron (p. 62).

We have already seen that according to V*r*inda and C. p., Nágárjuna was the first to introduce the preparation known as Kajjvali (black sulphide of mercury p. 61). Dalva*n*a also makes him the redactor of the Sus*r*uta.

The mention of Nágárjuna by all these authorities would not remove him far from the 8th or the 9th century A. D., a date which is also confirmed by Albérúní, who says:

"A famous representative of this art [alchemy] was Nágárjuna, a native of the fort Daihak, near Somnáth. He excelled in it and composed a book which contains the substance of the whole literature on this subject and is very rare. He lived nearly a hundred years before our time.' —'India, I. p. 189.

But there are difficulties in the way of accepting this chronolgy of the age of Nágárjuna. Hiouen Thsang, who resided in India from 629 A. D. onwards, relying upon local traditions, speaks of Nágárjuna [1] as a

(1) "Nagarjuno Bodhisatva was well practised in the art of compounding medicines; by taking a preparation (pill or cake)' he nourished the years of life for many hundreds of years, so that neither the mind nor appearance decayed. Satváha-rája had partaken of this mysterious medicine."—Beal's Buddhist Records of the Western World, vol. II, p. 212.

Again—Then "Nágárjuna Bodhisatva, by moistening all the great stones with a divine and superior decoction (medicine or mixture) changed them into gold."—*Ibid*, p. 216.

learned and revered Buddhist and alchemist, and a friend of King Satváhana.[2] The poet Vá*n*a, a contemporary of the Chinese pilgrim, also corroborates this account in his life of King Harsha.

In the Buddhist canonical literature, Nágárjuna is a prominent figure as the founder, or, at any rate, the systematiser of the Mádhyamika philosophy. Western scholars maintain that he lived in the 1st century A.D., while according to Rájatarañginí, the "History of Ka*s*mír" by Kalha*n*a Mi*s*ra (11 century A. D.), Nágárjuna flourished 150 years after Sakyasi*m*ha had betaken himself to asceticism, *i.e.* he lived in the last quarter of the 4th and first quarter of the 3rd century B. C. It is doubtful, however, if Nágárjuna, the philosopher, is the same as Nágárjuna, the alchemist, considering

(2) Nágárguna was a friend of Satváhana, a king of Kosala country to the South West of Urisya and watered by the upper feeders of the Mahánadi."—*Ibid*. II. p. 209. As to the age of Satváhana see Burgess' Archæological Survey of S. India. Regarding Nágárjuna see also Introd. a l' histoire du Buddh. Ind. p. 508.

that we find no reference whatever to the processes of distillatlon, sublimation etc. in the Charaka, the Susruta, and the Vágbhata, though it must be admitted that the latter can lay claim to superior chemical knowledge. (see p. xlviii).

Patañjali.

We have also another alchemist in Patañjali, who is better known as the commentator of Pánini. He probably lived in the 2nd century B. C.[1] Sivadása, in his commentary of Chakrapáni, quotes him as an authority on Lohasástra, or the "Science of Iron," and Chakrapáni himself speaks of him as the redactor of Charaka (see p. xv). Bhoja in his Nyáyavártika speaks of Patañjali, as a physician both to the mind and to the body.[2] The mokshá (salvation), as taught in the Yoga system of Pátañjali, is

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(1) Proof. Bhandarkar: Ind. Antiquary, 1872, pp. 299-302.

(2) "योगेन चित्तस्य पदेन वाचां मलं शरीरस्य तु वैद्यकेन ।
योऽपाकरोत् तं प्रवरं मुनीनां पतञ्जलिं प्राञ्जलिरानतोऽस्मि ।"

—Bhoja: Nyáyavártika, quoted by *Sivaráma*, the commentator of Vásavadatta.

also connected with alchemy.[3] We have already seen, while discussing the "Philosophy of Mercury" (see *ante* p. lxxvi), the Rasáyana or Alchemy was simply regarded as a means to an end—as a path leading to moksha. It is significant that this connection can be traced from so early a date.

Progress of chemical knowledge in Europe.

In the present volume we shall seldom have occasion to go beyond the 14th century A. D. It will, perhaps, add to the interest of the subject, if we turn our eyes for a moment to the progress of chemical knowledge in Europe at that time, and the alchemistic ideas and beliefs dominating it. Contemporary with the authors of Rasárnava and Rasartnasamuchchaya, were Roger Bacon (d. 1294), Alertus Maguns, Raymond Lully, and Arnaldus Villanovanus. Roger Bacon does not hesitate to assert that the philoso-

(3) The author (Patañjali) adds to the three parts of the path of liberation a fourth one of an illusory nature, called Rasáyana, consisting of alchemistic tricks with various drugs, intended to realise things which by nature are impossible."—Albérúní's 'India' —I. p. 80.

pher's stone was able to transform a million times its weight of base metal into gold. The above-named alchemists are also unanimous in regarding it as a universal medicine, and "it was no unusual assertion that adepts, the fortunate possessors of the panacea, had been able to prolong their lives to 400 years and more."—Meyer. The readers of Rasár*n*ava and the other Tantras will not fail to find that there is much in common between the Hindu alchemists and their European *confrères.*

Knowledge in practical chemistry, prevalent in India in the 12th and 13th centuries A. D., and perhaps in earlier.

The knowledge in practical chemistry, prevalent in India in the 12th and 13th centuries A. D., and perhaps earlier, such as we are enabled to glean from Rasár*n*ava and similar works, is distinctly in advance of that of the same period in Europe. It was known for instance that blue vitriol and a variety of the pyrites (see p. 70) yielded an essence in the shape of copper; and calamine, zinc. The colour of flames as a

diagnostic test of metals was well understood (p. 68). The metallurgical processes, described under the latter, leave little to improve upon (p. 88), and, indeed, they may be transferred bodily to any treatise on modern chemistry. Even Paracelsus, who flourished some three centuries later, leaves us in the dark as to the nature of his 'zinken,' which he designates a 'semi' or 'bastard' metal. And Libavius (d. 1616) "who stood up manfully against the excesses of Paracelsus, and who vigourously combated the defects in his doctrines, * * * and the employment of "secret remedies," believed in the transmutation of the metals and the efficacy of potable gold.[1] It is not necessary to pursue this subject further here, as details will be found in the chapter on metallurgy (pp. 152-169).

The truth is that up till the time to pseudo-Basil Valentine (ca. 1600 A. D.),

(1) Gesch. d. chem. I. 13.

very little scientific progress was achieved in Europe. The doctrines of Aristotle and of the Arabian alchemists held the ground, and the enigmatic and mystic language, which was often used as a cloak for ignorance, simply confounded the confusion.

Still more solid progress was effected in pharmacy. For two thousand years or more the Charaka and the Susruta have been paid all the honours of a state-recognised Pharmacopœia. Partly due to their being regarded as of revealed origin, and partly due to that veneration for the past, which is inherent in the Hindu, the text of the above works has seldom been allowed to be tampered with. A critical examination of the Bower Ms. such as we owe to Dr. Hoernle, shows that the recipes of several important preparations agree in all essentials, and sometimes word for word, with those of the Charaka and the Susruta of the existing recensions (see *ante* p. xix). Mr. Ameer Ali is scarcely correct when he claims that "the Arabs invented chemical pharmacy, and were the founders of

those institutions which are now called dispensaries.'[1]

We have only to refer our reader to the chapter on the preparation of caustic alkali, in the Susruta, with the direction that the strong lye is to be "preserved in an iron vessel," as a proof of the high degree of perfection in scientific pharmacy achieved by the Hindus at an early age (p. 37). It is absolutely free from any trace of quackery or charlatanism, and is a decided improvement upon the process described by a Greek writer of the IXth century, as unearthed by M. Berthelot.[2] As regards *dispensaries* and hospitals, every one knows that Budhistic India was studded with them (*vide* p. xxxii).

Speaking of the progress of chemistry in Europe in the XVIth century, Prof. Schorlemmer remarks :—

"Up to the XVIth century almost the sole object of chemical research had been to find the

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(1) Hist. of the Saracens, p. 462, (Ed. 1899.)

(2) See p. 22.

philosopher's stone. But now chemistry began to develop itself two new and different paths, opened by two distinguished men—Agricola, the father of metallurgy, and Paracelsus, the founder of Iatro-chemistry or medical chemistry. Both contributed chiefly to the development of inorganic chemistry * * * In opposition to the school of Galen and Auicenna, Paracelsus and his followers chiefly employed metallic preparations as medicines." [1]

Udoy Chand Dutt, in the preface to his *Materia Medica of the Hindus,* states :—

"The oldest work, containing a detailed account of the calcination or preparation of the different metals (such as gold, silver, iron, mercury, copper, tin and lead) for internal use with formulæ for their administration, is, I believe, a concise treatise on medicinal preparations by Sãrngadhara.

This is evidently a mistake. Sárngadhara is simply a compilation based upon the Charaka and the Susruta on the one hand, and the Tántric works described above on the other. It cannot be regarded as going beyond the latter part of the 14th century, and

(1) Rise and development of Orgatiic chemistry (ed. 1894) p. 9.

it will come under our notice in the second volume of the present work. In the European histories of chemistry, the credit of being the first to press chemical knowledge into the service of medicine and introduce the use of the internal administration of mercurial preparations, is given to Paracelsus (1493-1541) The Nágárjunas and the Patanjalls of India, however, had the merit of anticipating Paracelsus and his followers by several centuries. The earliest historical record of the internal use of black sulphide of mercury dates so far back as the 10th century A. D. at the latest[1] (see *ante* p. 59). We have indeed, reasons to suspect that Paracelsus got his ideas from the East, and in Chapter on *Arabian indebtedness to India* we have pointed out the media through which Indian sciences filtered into Europe.

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(1) In Europe, its use dates from the 17th century. "Das schwarze Schwefelquicksilver lehrte zuerst Furquet de Mayerne im Anfange des 17, Jahrhunderts, durch Zussanmmenreiben von warmen Quicksilver mit geschmolzenem *Schwefel* darstellen." Kopp. Gesch, 186.

Dutt says: "We cannot help admiring the ingenuity and the boldness of the Hindu physicians, when we find that they were freely and properly using such powerful drugs as arsenic, mercury, iron, etc., when the Mussulman Hakims around them with imperial patronage and the boasted learning of the West, recording such remarks regarding them as the following:—

' Soomboolkhar, 'the white oxide of arsenic.—' There are six kinds of this, one name Sunkia, the third Godanta, the fourth Darma, the fifth Huldea. The Yunāni physicians do not allow this to form a part of their prescriptions, as they believe it destroys the vital principle. The physicians of India, on the coutrary, find these drugs more effectual in many disorders than others of less power such as the calx of metals. For this reason too I am in the habit of seldom giving these remedies internally, but I usually confine my use of them to external application and as aphrodisiacs which I prescribe to a few friends, who may have derived no benefit from Yunāni prescriptions. It is better to use as few of them as possible." [1]

"Pārā, 'Mercury.'—It is very generally used throughout India in many ways, both in its native

(1) Taleef Shareef trans. George Playfair, p. 99.

and prepared state, but in the latter we ought to be very cautious, for it is seldom sufficiently killed or removed from its native state, in which it is a dangerous drug."[1]

"Loha, 'iron.'—It is commonly used by physicians in India, but my advice is to have as little to do with it as possible."[2]

Nor must we forget that so late as 1566 A. D. the Parliament and the Faculty of medicine, Paris, condemned and forbade what was regarded as the dangerous innovations of Paracelsus.[3]

Apart from the historical data already adduced, the above extracts from a Mohammedan writer would show that the Hindus were perhaps the earliest in the field to advocate the internal use of mercury.[1] Ainslie, in a note appended "Lepra Arabum," written in the early part of the last century, thus expresses his views on the subject :—

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(1) *Ibid*, page 26.

(2) Taleef Shareef, page 146.

(3) Gesch. d. Chem. I, 110.

note appended to " Lepra Arabum," written in the early part of the last century thus expresses his views on the subject :—

" It is well known that the Eastern nations were the first who employed mercury in the cure of obstinate, cutaneous and leprous affections; and it may be questioned whether the natives of India were before the Arabian or only second in order in availing themselves of the virtues of that powerful mineral. Rhases,[1] Mesu and Avicenna[2] all notice it, and according to Fallopius, as we find observed by Le Clerc in his "Histoire de la Médicine" pp. 771-791, it was the opinions of those writers which first suggested its use in venereal diseases.[3]

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(1) "Argentum vivum cum extinguitur ardens est, quod scabei, et pediculis auxilium offert "—Rhazes :" de Re med." (lib iii. cap. xxiv). In the days of Pliny the Elder the medicinal virtues of mercury do not appear to have been at all ascertained; that writer termed quicksilver the bane and poison of all things and what would with more propriety be called *death* silver. "Nat. Hist." lib xxxiii. Cap. vi).

(2) Avicenna says of mercury "argentum vivum extinctum adversus pediculos et lendes cum rosaseo oleo valet." *Vide* ." lib. ii. tract. ii. p. 119.

(3) Trans. R. As. Soc. (1824-27).

From the evidences we have adduced all along there can now be scarcely any question as regards the priority of the Hindus in making mercurial remedies a speciality; and they are entitled to claim originality in respect of the internal administration of metals generally seeing that the Charaka and the Susruta, not to speak of the later Tantras, are eloquent over their virtues.

CHAPTHR VI.

Indebtedness of the Arabians to India.

The Arabians are acknowledged on all hands to have played a prominent part in the propagation of science and mathematics in the West. When in the dark and middle ages, the lamp of knowledge had begun to burn very low in Europe and even when the very vestiges of Greek culture and learning had all but disappeared, save in the obscure and dingy cells of the monk, it was the Arabs who carried there the accumulated intellectual treasures of the East, and thus laid the foundation, so to speak, of modern European greatness.

It will, perhaps, be not out of place to discuss here briefly as to how much India indirectly contributed to this result in the departments of medicine, pharmacy and other kindred subjects.

The author of *Kitāb-al-Fihrist*, who wrote towards the middle of the tenth century[1], Haji Khalifa and Ibn Abú Usaibiah, who flourished at the commencement of the 13th century, distinctly mention that by order of the Caliphs Harun and Mansur several standard Hindu works on medicine, materia medica and therapeutics were translated into Arabic. The information on the subject has been gathered at length by Dietz in his *Analecta medica*, Wustenfeld, author of *Geschichte der Arab. Aerzte*, Cureton[2], Flügel, Müller and other Arabic scholars.

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(1) ...." Abu'l Faraj Mohammed bin Ishak, surnamed an-Nadim, a native of Bagdad, first conceived the idea of a bibliographical dictionary. His Kitāb-al-Fihrist deals with every branch of learning. It gives the names of many authors and their works which have ceased to exist."—*Hist. of the Saracens* by Ameer Ali, p. 469.)

(2) Prof. H. H. Wilson in a *Note* appended to a paper by the Rev. W. Cureton entitled " A collection of such passages relative to India as may occur in Arabic writers" thus pithily summarises his own views :—" In medicine the evidence is more positive, and it is clear that that the *Charaka*, the *Susruta*, the treatise called *Nidāna* on diagnosis, and others on poisons, diseases of women and therapeutics, all familiar to Hindu Science, were translated and studied by the Arabs in the days of

Flügel[1] states on the authority of *Kitāb-al-Fihrist* that *Susrud* (the Sanskrit name Susruta, thus corrupted into Arabic) was translated by Mankh, the Indian, who cured Harun ar-Raschid of a severe illness, and was appointed physician in charge of the Royal Hospital. We also learn that a work on the official plants of India was rendered into Arabic by the same Mankh. The other comprehensive Sanskrit treatise, the Charaka was also fully laid under contribution.

We have ample and overwhelming testimony of Arabic writers, notably of Haji Khalifa, that Hindu astronomy, algebra and medicine were zealously studied by their compatriots, and many Hindu servants were induced to reside at the Court of the Caliphs as their instructors. Mussulman students,

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Harun and Mausur, either from the originals or translations, made at a still earlier period, into the language of Persia."—*Journ. Royal Asiatic Soc.* old series, vi. pp. 105-115.

(1) "Zur Frage über die altesten Uebersetzungen indischer und persischer medicinischer Werke ins Arabische; Ziet. deut. morg. Ges. xi. pp 148 and 325.

in their eager thirst for knowledge, used to flock to the centres of learning in India, and there drank deep at the very fountain-head. Indeed, it had come to be regarded as an essential part of completing one's liberal education to travel to India and learn the sciences firsthand.

That this is no language of rhetoric will be evident from the extracts quoted below from Gildemeister's "Scriptorum Arabum De Rebus Indicis loci et opuscula."

"Etiam Muhammed ben Ismaîl al Tanûkhi in Indiam profectus est eo imprimis consilio, ut Indorum astronomiam cognosceret.

"Ibn Albaithâr, rei herbariæ inter Arabes peritissimus, qui and eius disciplinae studium longinqua itinera per Hispaniam Africam et Asiam instituit, etiam in Indiam venit, teste Leone Africano: Abulfadà tamen et Ibn Abi Ucaibia, qui de eius vita scripserunt, eius rei mentionem non faciunt." p. 80.

"Sed etiam accuratius edocti erant, et scite iam vetus Indopleusta eas disciplinas, in quibus Indi maxime excellerent, nominat has: medicinam, philosophiam et astronomiam. Eodem modo Hagi

Khalfa arithmeticam, geometriam, medicinam, astronomiam et metaphysicam enumerat." p. 81.

"De libris ex Indica lingua in Arabicam conversis iam inter Arabes egerunt ii, qui libros de re literaria composuere. Plurimi de iis sine dubio apud Hag'i Khalfam legentur, cuius hucusque pars tantum publico usui patet. De antiquioribus his libris locuples testis est antiquissimus de Arabum literis scriptor Ibn Abi Yaqub ibn Alnadîm, qui in *Indice scientiarum* * * * * * quem scripsit anno 337 (inc. 10 Jul. 948) inter monumenta literarum Arabicarum etiam peculiari cura egit de libris e linguis Graeca, Persica et Indica conversis." p. 82.

Müller's refutation of Haas.

Haas, whose criticism of the Susruta we have already noticed, having once taken up the position of denying the antiquity of Hindu medicine with special regard to the Charaka and the Susruta, was driven to the necessity of discounting, nay, explaining away, the numerous references to Hindu works made by Mussulman writers. This had the effect of eliciting a reply from Müller, who subjected the Arabic literature bearing on the subject to a

crucial examination, especially Book XII of Useibia. He finds that not only the Charaka and the Susruta, but also the Nidána and the compendium Asânkar,[1] a book on Poison by Sánáq the Indian, and another on Warm and Cold, and several other works were rendered into Arabic. This German orientalist also arrives at the conclusion that Indian physicians practised at the Court of Bagdad.[2]

Albérúnís evidence.

We have now to place before the reader the evidence of a remarkable author—remarkable alike for the depth of his learning, versatility of his genius, rare impartiality of his judgment and his singular freedom from race-bias.

Albérúní lived in India from 1017-1030 A. D., and during this long sojourn he mastered Sanskrit and studied Hindu mathema-

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(1) A Variant has "Astankar," which will be readily identified as the Astánga of Vágbhata (see p. xlvii.)

(2) "Schon vor Er-Rasid, vielleicht sogar gleichzeitig mit dem Uebergange indischer Astronomie nach Bagdad.........haben sich auch indische Aerzte in Bagdad eingefunden." (Loc. cit. p. 499). "Arabische Quellen zur Geschichte der indischen Medizin."—"Zeit, deut, morg. Ges. 34. p. 465."

tics and philosophy in the original. At a time when his patron, Sultan Mahmud of Ghzni, was busy pillaging the temples in Thaneswar, Mathura, Kanauj and Somnath with the zeal of an iconoclast, this philosophic Moslem was pondering over the Sá*m*khya and the Pátañjala, and instituting a comparison between their contents and those of the "Timæus" and its commentator, Proclus.

We have elsewhere quoted at length Albérúní's views on Rasáyana (alchemy) ; it now remains for us to glean such information from him as will throw light on the subject under inquiry. According to Sachau, the learned translator of Albérúní, "some of the books that had been translated under the first Abbaside Caliphs were extant in the library of Albérúní, when he wrote his India, the Brahmasiddhánta or Sindhind.........the Charaka in the edition of Ali Ibn Zain and the Pañchtantra or Kalila and Dimna." The fact that the Charaka occupied a place in the library of a cultured Arab affords an additional proof of the esteem in which the Hindu system of

medicine was held by the Moslem world. We also learn that "the Christian philosopher and physician from Bagdad, Abulkahir Alkhamnour, friend of Albérúní, seems to have practised in Ghazni his medical profession" (Sachau). This is significant as indicating that both the Greek and Hindu systems held sway side by side; but more of it anon.[1]

Internal evidence.

So far as regards historical evidence. Let us now see if any internal evidence could be gathered in corroboration of the former. Reference has already been made to the Book on Poisons by Sânâq the Indian. We shall cite here some parallel passages on the Examihation of Poisoned Food and Drink. These are the chief characteristics as given by Sânâq, the Charaka and the Susruta respectively.

(1) "Dietz also in his Analecta Medica proves that the later Greek physicians were acquainted with the medical works of the Hindus, and availed themselves of their medicaments; but he more particularly shows that the Arabians were familiar with them, and extolled the healing art, as practised by the Indians, quite as much as that in use among the Greeks."—Royle: "Antiq. Hind. Med." p. 64.

SANAQ THE INDIAN	THE CHARAKA	THE SUSRUTA
The vapor emitted by poisoned food has *the colour of the throat of the peacock* . . . . *when the food is thrown into fire, it rises high in the air; the fire makes a cracking sound* as when salt deflagrates . . . . . the smoke has *the smell of a burnt corpse.* Poisoned drinks: *butter milk and thin milk have a light blue to* yellow line.	*The food is to be thrown into fire for testing* . . . . the flame becomes *parti-coloured like the plume of a peacock.* The tongue of the flame also becomes pointed; *a crackling sound is emitted* and *the smell of a putrid corpse is perceived.* . . . *Water, milk and other drinking liquids*, when mixed with poison, *have blue lines printed upon.*—"Chikitsá," Ch. xxiii, 29-30.	When poisoned food is thrown into fire, it *makes crackling sound and the flame issuing therefrom is tinted like the throat of the peacock*— "Kalpa," Ch. i, 27.

The physician, as superintendent of the kitchen, well-versed in toxicology, is essentially an Indian institution. Cf. Susruta, Kalpa, Ch. I. 6-9

Müller has pointed out the parallelism as shown above. We have, however, added to it the diagnostic test of poisoned food as

given in the Charaka, and it will be seen that Sânâq was equally indebted to this authority and to the Susruta.

The description of leeches as given by Rases agrees almost word for word with that of the Susruta (Sanasrad) in many places.

Susruta	Rases, quoting Sanasrad
The variety of leeches called *Krishná* is *black* in colour and have *thick heads*, *Karvurás* have their bodies, like that of eels with elevated stripes across their abdomen. *Alagardhás* have hairs on their bodies, large sides and black mouths. *Indráyudhás* have longitudinal lines along their back, *of the colour of the rainbow.*	Of the leeches one is poisonous, *which is intensely black like antimony having a large head*: and scales like certain fishes and having the middle green: also another upon which are hairs, has a large head and *different colour like the rain-bow*:
Sâmudrikás are of a dark-yellow colour and have variegated spots on their bodies resembling flowers in appearance. *Gochondanás* have bifurcated tails like the two horns of a cow and small heads. *When these poison-*	

ous leeches bite any person, the bitten parts become swollen and very itchy, and fainting, fever, burning of the body, vomiting, mental derangement and langour occur. In these cases the medicine called *Mahāgada* should be administered internally, applied externally and used as snuff. The bite of the leech called *Indrāyudha* is fatal. Such is the description of the poisonous leeches, and their treatment.

Now the non-poisonous leeches. Their names are as follows: *Kapilā, Pingalā, Sankumukhi, Mūshikā, Pundarikamukhi and Sāvarikāa*

Kapilā have their sides of *the colour of orpiment*

and their back smooth and of the colour of the pulse called

in the colour of which there are lines as in blue-spar, bluestone, azure—*which often bites: thence will be caused abscess with fainting*: with coma and relaxing of the joints: nevertheless of these very leeches there is a good one which is assimilated to the colour of water:

in which there will be greenness having upon it two lines like *arsenic* [orpiment] but light red,

mudga (Phaseolus mungo). Fingalas have round bodies, move quickly, and are of slightly red or tawny colour. *Sāukuhmukhis are liver-coloured, suck blood quickly,* and have large sharp mouths.

nay coloured and corresponding to the colours of liver: which are swift to draw to themselves fine blood:

Mushikas have the colour and shape of rats and a bad smell.

which are assimilated to the tail [colour] *of a mouse: having a horrible smell* * * *

Pundarikās have mouths like the lotus and are of the colour of the pulse of *Phaseolus mungo. Sāvarikās* have green colour like the leaf of the lotus, are functuous, and eighteen fingers in length. They are used only for extracting blood from beasts. Such is the description of the non-poisonous leeches. The non-poisonous leeches are fouud in Turkey, *Pāndya* (the country to the south), *Sahya* (a mountain on the banks of the *Narbadā*)

And having the belly red along with blackness

and *Pautana* (the tract of country about Mathuro). Of non-poisonous leeches, those which are stronger and have large bodies, can drink blood rapidly and eat much, are especially free from poison.

and the back green : they are

Leeches which are produced in dirty water and from the decomposition of poisonous fishes, insects, frogs, urine and fæces are poisonous. *Those produced in pure water* and from the decomposition of the different varieties of the *Nelumbium Speciosum* and the *Nymphæa lotus* and of *Saivāla (Blyxa octandra) are non-poisonous.*

The vatieties of *Nymphæa* mentioned here are *padma, utpala, kumuda, nalina, kuvalaya, saugandhika* and *pundarka.*

On this subject there is the following verse :—Non-poisonous leeches go about in the field and fragrant water. They do not live in confined

bitter but they will be worse in bad water quite stagnant in which are many small tadpole frogs: *nevertheless, they are good in good and excellent water.*

places or lie in mud as they seek comfort. These should be caught by means of wet-leather or some other article. They should be kept in a new large earthen pot filled with mud and water from a tank. Mosses, dried flesh and powdered tubers of water-plants should be given them for food. For bedding they should be furnished with grasses and leaves of water-plants. Fresh water and food should be given every second or third day, and every seventh day the earthen pot should be changed. On the subject there is the following verse :

Leeches which are very thin or thick or with their central portions thick, which move slowly or do not stick to the part to which they are applied, which drink little blood, or which are poisonous, are not fit for use. When about to apply leeches on a person who has got a disease curable by them, the patient should be made to sit or lie

also when they are seized or caught, let them be put away while all that which is in their own belly is being purged; also they ought not to be put on except in a place not healthy;

down. The affected part, if free from pain, should be rubbed with a little cowdung and earth. The leeches should then be taken hold of and smeared with a mixture of turmeric and mustard reduced to a paste with water. They should then be placed for a while in a cup of water, till they are relieved of their weariness and afterwards applied to the diseased part. *When being applied, their mouths should be left open and their bodies covered with fine white wet rags.*

If they do not bite, a drop of milk or blood should be applied to, or a small incision may be made on the diseased part. *If even by these means a leech cannot be applied, it should be changed for another.*

A leech is known to have fixed itself to the part when it raises its shoulder and bends its head like a horse-shoe. When fixed it should be covered

also anointments ought to be made around the place with paste that they may not touch the healthy place: *also as often as leeches are applied, put over them a fine soaked cloth:*

If a leech does not stick let the place be anointed with milk or with blood: if it still refuses to bite, let another be applied in the place of it.

with a piece of wet cloth and a little water sprinked on it occasionally. If the part bitten by a leech itches or is painful, it is a sign that the leech is drawing pure blood and it should be removed from the part.

If from fondness for blood it cannot be readily removed, a little rock-salt should be sprinkled on its head. ‡

but if you wish that they fall off, sprinkle their heads (mouths) with salts and keep them in a jar. †

There is thus unmistakable evidence here of the use of a chapter of the Susruta or some such work.

Then again several drugs, which are repeatedly mentioned in the Charaka and are almost exclusively Indian products, have been borrowed in the materia medica of Useibiah

‡ Dutt's Trans.

† The version of Rases, being in the "dog" Latin of the middle ages, is not always very intelligible to us.

and others. The following may be taken as examples: Pepper,[1] lac, nard,[2] liquorice, assafœtida occimum, sanctum, bdellium, cinnamon, the chebulic myrobalans, calamus acorus, agallacha,[3] berberis asiatica, [4] myrrh, melia azadirechta, calotropis, (asclepias), and red sandal. To quote Gildemeister:

"Ex. hac Indiae parte asportatur agallochum Kumârense, quod inde nomen cepit." p. 156.

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(1) Dioscorides also mentions the three peppers. Arabian physicians of the tenth century also describe their properties. See Dymock, Warden and Hooper's "Pharmacographia Indica," III, pp. 176-185.

(2) "Nardostachys jatamansi," the Nardin of Dioscorides, called also "Gangitis," because the Ganges flowed from the foot of the mountains where the plant grows: *ibid* II. p. 234.

(3) For the discussion of agallocha (sans. अगुरु), see also "Script. arab. de Reb. Ind.," pp. 65-72.

(4) The extract of the wood was also known to the Greeks under the name of Indian Lycium. "Pharm. Ind.," I. 65.

Cf. "Among the strictly Indian products, we have the two kinds of Pepper (long and round), Cardamoms and Ginger (?) . . . . . the "Dolichos," mentioned by Hippocrates and Theophrastus, as well as by later authors, is considered to be "Phaseolus Vulgaris, and to have been introduced from India in the time of Alexander." Royle: "Antiquity of Hindu Med.," Lond., 1837, p. 121.

"Abuldhalí Sindius dum Indiae regiones describit, dicit :

' Negarunt quidem sodales mei nec tamen istud praestantissimum est.

"Quando laudabatur India Indaque sagitta in campo caedis.

"Per vitam meam! terra est: in quam si pluvia decidit.

"Contingunt hyacinthi et uniones ei qui monilibus caret.

"Ibi originem habent muscus et camphora et ambarum et agallochum

"Et aromatum genera, quibus utuntur qui inodori sunt.

"Et odoramentorum species et myristica et spica nardi ;

' Ibi ebur et tectonae lignum, ibi lignum aloes et santalum

"Ibique est tutia montis instar longissimi." pp. 217-218.

That the Charaka should be changed by Arabic writers into "Sarak," Susruta into "Susrud," Nidána into "Badan," Astánga into "Asankar" and so forth, need not at all surprise us. Such transformations can well be explained on phonetic principles. Moreover,

one must remember that the Indian works translated into Arabic were sometimes derived from preëxisting Phelvi versions, and in the migrations through successive languages, the names often got frightfully disfigured. A notable instance of this kind is afforded by the fables of Pilpay (Kalila and Dimna[1]) from which La Fontaine borrowed the idea of several of his fables as he himself acknowledges : "I shall only say, from a sense of gratitude, that I owe the largest portion of them to Pilpay, the Indian sage." It has now been made out that Pilpay or Bidpai is a corrupt form of the Sanskrit word "vidyápati" (master of learning).

Even long before the time of the Caliphs, India was the favourite resort of the students of medicine and other sciences. Thus Barzouhyeh, a contemporary of the celebrated

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(1) ". . . . . . et malgrè l'espece de transformation que ce livre a dû subir en passant de l'indien en pehlvi, du pehlvi en arabe, de l' arabe en persan, on y retrouve encore des caractères frappans de cette origin . . . . . ."—de Sacy "Calila et Dimna ou Fables de Bidpai, (1816), p. 5.

Sassanian king Nashirván, (A. D. 531-572), visited India to acquire proficiency in the Indian sciences.[1]

Arabian indebtedness to India ignored by the European historians of chemistry.

Thomson, Hoefer, Kopp, and Berthelot have done ample justice to the claims of the Arabians as the originators or, at any rate, as the propagators of alchemy in Europe in the middle ages. M. Berthelot, indeed, has recently shown that the ideas and theories, as regards alchemy, humoral pathology and physiology, which were promulgated in the writings of Geber, Rases, Avicenna, Bubacar and others, were essentially Greek in origin, though extended and improved upon by the Arabians. The French savant has, however, presented only one side of the

(1) ". . . . . . que Barzouyèh dans sa jeunesse, avoit déjà fait un premier voyage dans l' Inde, pour y rechercher des substances médicinales et de simples, et que c'était dans ce voyage qu' il avoit acquis la connoissance de la langue et de l'écriture Indiennes . . . . . ." *ibid*, p. 23.

shield.[1] In short, European historians of chemistry have scarcely one word to say on the indebtedness of the Arabians to the Hindus, who contributed not a little to the making of a Rases, a Serapion, or an Avicenna, who, in turn, were the chief inspirers of the European iatro-chemists down to the 17th century.[2]

Prof. Sachau, however, does justice to the claims of India.

Prof. Sachau, the learnedt ranslator and editor of Albérúní's India, however, does justice to the

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(1) Cf. "—les Arabes, héritiers et traducteurs de la science grecque."—Berthelot : "La Chimie au moyen âge," I. préface, ii. "Les sciences naturelles furent surtout étudiées aux ixe et xe siècles, dans la célèbre école des médecins syriens de Bagdad, attirés et protégés par leurs clients. Dioscoride, Galien, Paul d'Egine furent ainsi traduits du grec en syriaque, puis en arabe ; parfois même traduits directement dans cette derniere langue." *ibid*, iv. "Les califes recherchaient les savants syriens, à cause de leur habileté médicale............or toute leur science venait des Grecs" *ibid* II., Introduction, iii.

(2) Speaking of Albert the Great and Roger Bacon. Kopp writes : "beide haben aus derselben Quelle, den Arabern, geschöpft." "Gesch. d. chem." 1, 64. Draper equally ignores the contributions of the Hindus : *e.g.*, "The teachers of the Saracens were the Nestorians and the Jews." "Hist. Intell. Dev. of Europe," Vol. I. p. 384, ed. 1896.

claims of both Greece and India in this respect, when he remarks :—

"The cradle of Arabic literature is not Damascus but Bagdad, the protection necessary for its growth being afforded by the Caliphs of the house of Abbas.

"The foundation of Arabic literature was laid between 750-850 A.D. The development of a large literature with numerous ramifications carried out with foreign materials, as in Rome the *origines* of the national literature mostly point to Greek sources. Greece, Persia and India were taxed to help the sterility of the Arab mind."

We cannot conclude this chapter better than sum up its substance in the words of Prof. Sachau :—

"What India has contributed reached Bagdad by two different roads. Part has come directly in translations from the Sanskrit, part has travelled through Eran, having originally been translated from Sanskrit (Pālī ? Prâkrit ?) into Persian, and farther from Persian into Arabic. In this way, *e.g.* the fables of Kālīla and Dimna have been communicated to the Arabs, and a book on medicine, probably the famous Charaka *cf.* "Fihrist," p. 303.

"In this communication between India and Bagdad we must not only distinguish between two different roads, but also between two different periods.

"As Sindh was under the actual rule of the Khalif Mansûr (A. D. 753-774), there came embassies from that part of India to Bagdad, and among them scholars, who brought along with them two books, the "Brahmasiddhânta" of Brahmagupta (Sindhind), and his "Khandakhâdyaka" (Arkand). With the help of these pandits, Alfâzarî, perhaps also Yakub Ibn Târik, translated them. Both works have been largely used, and have exercised a great influence. It was on this occasion that the Arabs first became acquainted with a scientific system of astronomy. They learned from Brahmagupta earlier than from Ptolemy.

"Another influx of Hindu learning took place under Harun, A. D. 786-808. The ministerial family Barmak, then at the zenith of their power had come with the ruling dynasty from Balkh, where an ancestor of theirs had been an official in the Buddhistic temple *Naubehâr i. e. navavihâra*, the new temple (or monastery). The name Barmak is said to be of Indian descent, meaning *paramaka*, *i. e.* the superior (abbot of the *vihâra*?). *Cf.* Kern, "Geschichte des Buddhismus" in Indien, ii, 445.

used all over the world. The influence which the decimal system of reckoning dependent on those figures has had not only on mathematics, but on the progress of civilisation in general, can hardly be over-estimated. During the 8th and 9th centuries the Indians became the teachers in arithmetic and algebra of the Arabs, and through them of the nations of the West. Thus, though we call the latter science by an Arabic name, it is a gift we owe to India."

We have thus far attempted to present our readers with a brief, hurried and necessarily imperfect survey of the gradual evolution and development of Hindu medicine and alchemy from the Vedic age onward. We hope we have been justified in dividing this entire range into four distinct periods, each characterised by fairly well defined features. There are of course no sharp lines of demarcation—the one imperceptibly merging into the other. These are (1) The Ayurvedic Period; (2) The Transitional period; (3) The Tantric period; (4) The Iatro-chemical period.

543. Of course, the Barmak family had been converted, but their contemporaries never thought much of their profession of Islam, nor regarded it as genuine. Induced probably by family traditions, they sent scholars to India, there to study medicine and pharmacology. Besides, they engaged Hindu scholars to come to Bagdad, made them the chief physicians of their hospitals, and ordered them to translate from Sanskrit into Arabic, books on medicine, pharmacology, toxicology, philosophy, astrology and other subjects. Still in later centuries Muslim scholars sometimes travelled for the same purposes as the emissaries of the Barmak, *e.g.* Almuwaffak, not long before Albérûnî's time ("Codex Vindobonensis, sive medici Abu Mansur liber fundamentorum pharmacologiæ, ed. Seligmann, Vienna, 1859, pp. 6, 10, and 15, 9."

We shall finish with another appropriate extract from Prof. Macdonell's recent work[1] :—

So also Prof. Macdonell.

" In Science, too, the debt of Europe to India has been considerable. There is in the first place, the great fact that the Indians invented the numerical figures

(1) " Hist. Sans. Lit." p. 424.

We shall now proceed to give a rough account of the chemical knowledge of each period—a more detailed description, especially of the Tantric period, being reserved for the second volume.

The *Ayurvedic* Period

(From the pre-Buddhistic Era to circa 800 A. D.)

CHAPTER I

The Constitution and Properties of Matter: the Atomic Theory

IT is not our purpose to discuss in the present volume the theories dominating Hindu medicine and, incidentally, chemistry. A concise preliminary summary of some of the salient features of the Sāṁkhya and Vaiseshika systems of philosophy is, however, absolutely needed in order to follow with advantage the excerpts given in this book from the Charaka, the Susruta and other works. In connection with this, it would also be interesting to compare the indebtedness of Hippocrates to the doctrines of Parmenides, Empedocles and other philosophers of the same school.[1]

(1) "Œuvres d' Hippocrate" by E. Littré, Paris, 1839, Tome 1, Intro. pp. 13 et seq. In connection with this chapter

Ka*n*āda, the founder of the Vai*s*eshika system, chiefly occupied himself with the study of the properties of matter. The atomic theory, as propounded by him, has many points in common with that of the Greek philosopher Democritus. His theory of the propagation of sound cannot fail to excite our wonder and admiration even at this distant date. No less remarkable is his statement that *light and heat are only different forms of the same essential substance.* But Ka*n*āda is anticipated in many material points by Kapila, the reputed originator of the Sā*m*khya philosophy. With the purely metaphysical aspects of these systems we are not concerned here. Their theories of matter and its constitution alone fall within the scope of our present enquiry. We shall now briefly refer to some of their doctrines.

The Sā*m*khya, in common with other systems of Hindu philosophy, teaches that salvation in after-life is only attainable by perfect knowledge. According to Kapila, there are three sources of knowledge which consists in right discrimination of the perceptible and imperceptible principles

the reader may also consult Gomperz' 'Griechische Denker", vol. 1. ed. 1903, specially the articles : "Die Aerzte" pp. 221-254, and " Die Atomistischen Physiker", pp. 254-298.

of the material world from the immaterial soul. He enumerates these principles to be twenty-five in number. For our present purpose, however a few of these only come within our purview. These we will present to our readers in the inimitable language of Colebrooke, whose masterly exposition of Hindu thought, though written nearly four scores of years ago, still retains its value and authoritative stamp[1] :—

Tanmātrās or Particles.

"Five subtile particles, rudiments, or atoms, denominated Tanmātras ; perceptible to beings of a superior order, but unapprehended by the grosser senses of mankind : derived from the conscious principle, and themselves productive of the five grosser elements, earth, water fire, air, and space.

Five Elements.

"Five elements, produced from the five elementary particles or rudiments. 1st. A diffused,

(1) Trans. Royal As. Soc., Vol. 1 pp. 19-43 and pp. 92-118 The European student who wishes to pursue the subject further may consult Max Müller's "Six Systems of Indian Philosophy" in which an ample and exhaustive bibliography will be found.

etherеal fluid (ākāsa), occupying space: it has the property of audibleness, being the vehicle of sound, derived from the sonorous rudiment or ethereal atom. 2nd. Air, which is endowed with the properties of audibleness and tangibility, being sensible to hearing and touch; derived from the tangible rudiment or ærial atom. 3rd. Fire, which is invested with properties of audibleness, tangibility and colour; sensible to hearing, touch and sight: derived from the colouring rudiment or igneous atom. 4th. Water, which possesses the properties of audibleness, tangibility, colour and savour; being sensible to hearing, touch, sight and taste; derived from the savoury rudiment or aqueous atom. 5th. Earth, which unites the properties of audibleness tangibility, colour, savour and odour; being sensible to hearing touch, sight, taste and smell; derived from the odorous rudiment or terrene atom.

Animated Atom.

"The notion of an animated atom seems to be a compromise between the refined dogma of an immaterial soul and the difficulty which a gross understanding finds in grasping the comprehension of individual existence, unattached to matter.

GROSSER BODY.

"The grosser body, with which a soul clad in its subtile person is invested for the purpose of fruition, is composed of the five elements, or of four, excluding the ethereal, according to some authorities; or of one earth alone, according to others. That grosser body, propagated by generation, is perishable. The subtile person is more durable, transmigrating through successive bodies, which it assumes, as a mimic shifts his disguises to represent various characters."

We now come to the treatment of the subject by Ka*n*āda in his famous Vai*s*eshika system. Here also we are indebted to Colebrooke for the following summary. Ka*n*āda arranges the objects of sense in six categories, viz., substance, quality, action, community, difference and aggregation. According to him:—

"I. Substance is the intimate cause of an aggregate effect or product: it is the site of qualities and of action; or that in which qualities abide, and in which action takes place.

"Nine are enumerated, and no more are recognised. Darkness has been alleged by some

philosophers; but it is no substance; nor is body a distinct one; nor gold which the Mīmā*m*sakas affirm to be a peculiar substance.

"Those specified by Ka*n*āda are:

EARTH.

"1. Earth which besides qualities common to most substances (as number, quantity, individuality, conjunction, disjunction, priority, posteriority, gravity, fluidity and faculty of velocity and of elasticity), has colour, savour, odour and feel or temperature. Its distinguishing quality is smell; and it is succinctly defined as a substance odorous. In some instances, as in gems, the smell is latent: but it becomes manifest by calcination.

"It is eternal, as atoms; or transient, as aggregates. In either, those characteristic qualities are transitory, and are maturative, as affected by light and heat: for by union with it, whether latent or manifest, form, colour, taste, smell and temperature are in earth of any sort annulled, and other colour etc. introduced.

"Aggregates or products are either organised bodies, or organs of perception, or unorganic masses.

'Organised earthly bodies are of five sorts. The organ of smell is terreous. Unorganic masses

are stones, lumps of clay, etc. The union of integrant parts is hard, soft or cumulative as stones, flowers, cotton, etc.

WATER.

"2. Water, which has the qualities of earth; excepting smell, and with the addition of viscidity. Odour, when observable in water is adscititious, arising from mixture of earthy particles.

"The distinguishing quality of water is coolness. It is accordingly defined as a substance cool to the feel.

"It it eternal, as atoms; transient, as aggregates. The qualities of the first are constant likewise; those of the latter inconstant.

"Organic aqueous bodies are beings abiding in the realm of Varu*n*a. The organ of taste is aqueous: witness the saliva. Unorganic waters are rivers, seas, rain, snow, hail, etc.

"It is by some maintained that hail is pure water rendered solid by the supervention of an unseen virtue: others imagine its solidity to be owing to mixture of earthly particles.

LIGHT.

"3. Light is coloured, and illumines other substances; and to the feel is hot: which is its

distinguishing quality. It is defined as a substance hot to the feel. [Heat, then, and light are identified as one substance.]*

"It has the qualities of earth except smell, taste, and gravity. It is eternal, as atoms; not so, as aggregates.

"Organic luminous bodies are beings abiding in the solar realm. The visual ray, which is the organ of sight, is lucid. Unorganic light is reckoned fourfold: earthy, celestial, alvine and mineral. Another distinction concerns sight and feel; as light or heat may be either latent or manifest, in respect of both sight and feel, or differently in regard to either. Thus fire is both seen and felt; the heat of hot water is felt but not seen; moonshine is seen, but not felt; the visual ray is neither seen nor felt. Terrestrious light is that, of which the fuel is earthy, as fire. Celestial is that of which the fuel is watery, as lightning and meteors of various sorts. Alvine is that of which the fuel is both earthy and watery: it is intestinal, which digests food and drink. Mineral is that which is found in pits as gold. For some maintain that gold is solid light; or, at least that

* The sentence under bracket is Colebrooke's own.

the chief ingredient is light which is rendered solid by mixture with some particles of earth. Were it mere earth, it might be calclined by fire strongly urged. Its light is not latent, but overpowered by the colour of the earthy particles mixed with it. In the Mîmâ*m*sâ, however, it is reckoned as a distinct substance, as before observed."[1]

After giving an account of air and ether etc., Colebrooke proceeds with Ka*n*âda's

(1) The term "element" was not generally used in the modern sense of a component of a compound; rather it connoted certain properties characteristic of matter, e.g., coldness, dryness, heaviness, fluidity etc., thus it referred to certain qualities in the abstract. The Greek philosophers also held similar, if not identical, views. Cf. "Empedokles und die moderne Chemie." pp. 185-86 of "Griechische Denker" by Gomperz vol. 1, ed. 1903. The following extract will also throw much light on the subject:

"The four so-called "elements"—air, water, earth and fire—were regarded by that intellectually great philosopher, Empedocles of Agrigent (about 440 B.C.), as the basis of the world; but neither he himself nor Aristotle, who adopted these into his system of natural philosophy, looked upon them as different properties carried about by one original matter. Their chief qualities (the *primæ qualitates* of the later scholastics) he held to be those apparent to the touch, viz., warm, cold, dry, and moist. Each of the four so-called elements is characterised by the possession of two of these properties, air being warm and moist,

Conception of the Simple, Binary, Tertiary, and Quaternary Atoms.

"Material substances are by Kaṇāda considered to be primarily atoms; and secondarily, aggegates. He maintains the eternity of atoms; and their existence and aggregation are explained as follows:

"The mote, which is seen in a sunbeam, is the smallest perceptible quantity. Being a substance and an effect, it must be composed of what is less than itself; and this likewise is a substance and an effect; for the component part of a substance that has magnitude must be an effect. This again must be composed of what is smaller; and that smaller thing is an atom. It is simple and uncomposed; else the series would be endless: and, were it pursued indefinitely, there would be no difference of magnitude between a mustard seed

water moist and cold, earth cold and dry, and fire dry and warm. The differences in the material world were, therefore, to be ascribed to the properties inherent in matter.

* * * *

"Aristotle considered that his four elements were insufficient in themselves to explain the phenomena of nature; he therefore assumed a fifth one, termed *ov'via*, which he imagined to possess

and a mountain, a gnat and an elephant, each alike containing an infinity of particles. The ultimate atom then is simple.

"The first compound consists of two atoms: for one does not enter into composition; and there is no argument to prove, that more than two must, for incohation, be united. The next consists of three double atoms; for, if only two were conjoined, magnitude would hardly ensue since it must be produced either by size or a number of patircles: it cannot be their size and, therefore, it must be their number. Nor is there any reason for assuming the union of four double atoms, since three suffice to originate magnitude. The atom then is reckoned to be the sixth part of a mote visible in a sunbeam.

"Two earthly atoms, concurring by an unseen peculiar virtue, the creative will of God, or time, or other competent, cause, constitute a double atom of earth; and, by concourse of three binary atoms, a tertiary atom is produced; and by

an ethereal or immaterial nature and to permeate the whole world. As the "*quinta essentia*" this played an immense *rôle* among the followers of the Aristotelian doctrine in the Middle Ages, and gave rise to endless confusion, from the endeavours of many (who, unlike Aristotle, supposed it to be material) to isolate it.

concourse of four triple atoms, a quaternary atom; and so on, to a gross, grosser, or grossest mass of earth: thus great earth is produced; and in like manner, great water from aqueous atoms; great light, from luminous; and great air, from ærial. The qualities that belong to the effect are those which appertained to the integrant part, or primary particle, as its material cause; and conversely, the qualities which belong to the cause are found in the effect.

"The dissolution of substances proceeds inversely. In the integrant parts of an aggregate substance resulting from composition, as in the potsherds of an earthen jar action is induced by pressure attended with velocity, or by simple pressure. Disjunction ensues; whereby the union, which was the cause of incohation of members, is annulled; and the integral substance consisting of those members, is resolved into its parts,

"There seems to be a high degree of probability in the assumption that Empedocles and Aristotle did not themselves deduce their theory of the elements, but derived it from other sources; thus the oldest writings of India teach that the world consists of the four elements mentioned above, together with ether, which last is most likely related to Aristotle's *οὐσία*—Meyer's "Hist. of Chem". Eng. trans. ed. 1898. pp. 7-8.

and is destroyed: for it ceases to subsist as a whole.

Quality of the Substance viz., Colour, Savour, etc.

'II. Quality is closely united with substance; not, however, as an intimate cause of it, nor consisting in motion; but common: not a genus, yet appertaining to one. It is independent of conjunction and disjunction; not the cause of them, not itself endued with qualities.

"Twenty-four are enumerated. Seventeen only are, indeed, specified in Kaṇâda's aphorisms; but the rest are understood.

"1. Colour. It is a peculiar quality to be apprehended only by sight; and abides in three substances; earth, water, and light. It is a characteristic quality of the last; and, in that, is white and resplended. In water it is white, but without lustre. In the primary atoms of both it is perpetual; in their products, not so. In earth it is variable; and seven colours are distinguished: *viz.* white, yellow, green, red, black, tawny (or orange) and variegated. The varieties of these seven colours are many, unenumerated. The six simple colours occur in the atoms of the earth;

and the seven, including variegated, in its double atoms, and more complex forms. The colour of integrant parts is the cause of colour in the integral substance.

"2 Savour. It is a peculiar quality, to be apprehended only by the organ of taste; and abides in two substances, earth and water. It is a characteristic quality of the last; and in it is sweet. It is perpetual in atoms of water; not so in aqueous products. In earth it is variable, and six sorts are distinguished: sweet, bitter, pungent, astringent, acid, and saline.

"3. Odour. It is a peculiar quality, to be apprehended only by the organ of smell; and abides in earth alone, being its distinguishing quality. In water, odour is adscititious, being induced by union with earthy particles; as a clear crystal appears red by association with a hollyhock, or other flower of that hue. In air also it is adscititious: thus a breeze, which has blown over blossoms, musk, camphor, or other scented substances, wafts fragrant particles of the blossoms, etc. The flowers are not torn, nor the musk diminished; because the parts are replaced by a reproductive unseen virtue. However, camphor and other volatile substances do waste.

* * * *

GRAVITATION.

"12. Gravity is the peculiar cause of primary descent or falling.

"It affects earth and water. Gold is affected by this quality, by reason of earth contained in it.

"In the absence of a countervailing cause, as adhesion, velocity, or some act of volition, descent results from this quality. Thus a cocoanut is withheld from falling by adhesion of the foot-stalk; but, this impediment ceasing on maturity of the fruit, it falls.

"According to Udayana Āchārya, gravity is imperceptible, but to be inferred from the act of falling. Vallabha maintains that it is perceived in the position of a thing descending to a lower situation.

LEVITY.

"Levity is not a distinct quality, but the negation of gravity.

FLUIDITY.

"13. Fluidity is the cause of original trickling.

"It affects earth, light and water. It is natural and essential in water; adscititious in earth and

light ; being induced by exhibition of fire in molten substances, as lac, gold etc.

"Fluidity is perceptible by external senses, sight and touch.

"In hail and ice, fluidity essentially subsists, but is obstructed by an impediment arising from an unseen virtue which renders the water solid.

Viscidity.

14. "Viscidity is the quality of clamminess and cause of agglutination. It abides in water only. In oil, liquid butter, etc., it results from the watery part of those liquids.

Sound.

"15. Sound is a peculiar quality of the ethereal element, and is to be apprehended by the hearing. It abides in that element exclusively and is its characteristic quality. Two sorts are distinguished : articulate and musical.

Theory of the Propagation of Sound.

"To account for sound originating in one place being heard in another, it is observed, that sound is propagated by undulation, wave after wave,

radiating in every direction, from a centre, like the blossoms of a Nauclea. It is not the first, nor the intermediate wave, that is the sound heard: but the last that comes in contact with the organ of hearing: and therefore it is not quite correct to say, that a drum has been heard. Sound originates in conjunction, in disjunction, or in sound itself. The conjunction of cymbals, or that of a drum and stick, may serve to exemplify the first. It is the instrumental cause. The rustling of leaves is an instance of disjunction being the cause of sound. In some cases, sound becomes the cause of sound. In all, the conformity of wind or its calmness is a concomitant cause: for an adverse wind obstructs it. The material cause is in every case the ethereal fluid: and the conjunction of that with the sonorous subject is a concomitant cause."

It now only remains for us to furnish a précis of the atomic theory of Kaṇāda in the words of Max Müller:

Aṇus or Atoms.

"What is thought to be peculiar to Kaṇāda, nay the distinguishing feature of his philosophy, is the theory of Aṇus or Atoms. They take the

place of the Tanmātrās in the Sāṁkhya philosophy. Though the idea of an atom is not unknown in the Nyāya-philosophy (Nyāya Sūtras, IV. 2, 4-25), it is nowhere so fully worked out as in the Vaiśeshika. Kaṇāda argued that there must be somewhere a smallest thing that excludes further analysis. Without this admission, we should have a *regressus ad infinitum*, a most objectionable process in the eyes of all Indian philosophers. A mountain, he says, would not be larger than a mustard seed. These smallest and invisible particles are held by Kaṇāda to be eternal in themselves, but non-eternal as aggregates. As aggregates again they may be organised organs, and inorganic. Thus the human body is earth organised, the power of smelling is the earthly organ, stones are inorganic.

"It is, no doubt, very tempting to ascribe a Greek origin to Kaṇāda's theory of atoms. But suppose that the atomic theory had really been borrowed from a Greek source, would it not be strange that Kaṇāda's atoms are supposed never to assume visible dimensions till there is a combination of three double atoms (Tryaṇuka), neither the simple nor the double atoms being supposed to be visible by themselves. I do not

remember anything like this in Epicurean authors, and it seems to me to give quite an independent character to Kaṇāda's view of the nature of an atom.

"We are told that water, in its atomic state, is eternal, as an aggregate transient. Beings in the realm of Varuṇa (god of the sea) are organised, taste is the watery organ, rivers are water inorganic."

"Light in its atomic state is eternal, as an aggregate transient. There are organic luminous bodies in the sun, sight or the visual ray is the luminous organ, burning fires are inorganic.

"Air, again, is both atomic and an aggregate. Beings of the air, spirits, etc., are organised air; touch in the skin is the ærial organ, wind is inorganic air. Here it would seem as if we had something not very unlike the doctrine of Empedocles. * * * But though we may discover the same thought in the philosophies of Kaṇāda and Empedocles, the form which it takes in India is characteristically different from its Greek form."[1]

(1) "Indian Philosophy", pp. 584-85.

Dates of the Philosophical Sūtras— The Question of Priority.

As regards the dates of the philosophical sūtras, nothing definite is known; here, as in the subsequent portions of our history, we have to depend largely upon constructive chronology.

We quote below two short extracts from Professor Max Müller's "Indian Philosophy" which summarise all the information available at present on the subject:

"If we consider the state of philosophical thought in India such as it is represented to us in the Brāhmaṇas and Upanishads, and afterwards in the canonical books of the Buddhists, we cannot wonder that all attempts at fixing the dates of the six recognised systems of philosophy, nay even their mutual relationship, should hitherto have failed. It is true that Buddhism and Jainism were likewise but two philosophical systems out of many, and that it has been possible to fix their dates. But if in their case we know something about their dates and their historical development, this is chiefly due to the social and political importance which they acquired during the fifth, the

fourth, and the third centuries B. C., and not simply to their philosophical tenets. We know also that there were many teachers, contemporaries of Buddha, but they have left no traces in the literary history of India.

* * * * *

"We cannot be far wrong therefore if we assign the gradual formation of the six systems of philosophy to the period from Buddha (5th century) to A*s*oka (third century), though we have to admit, particularly in the cases of Vedānta, Sā*m*khya and Yoga, a long previous development reaching back through Upanishads and Brāhma*n*as to the very hymns of the Rig Veda.

"It is equally difficult to fix the relative position of the great systems of philosophy, because, as I explained before, they quote each other mutually. With regard to the relation of Buddhism to the six orthodox systems it seems to me that all we can honestly say is that schools of philosophy handing down doctrines very similar to those of our six classical or orthodox systems are presupposed by the Buddhist Sūttas." (pp. 116—120)

As regards the question of priority, we shall also take the liberty to quote below from Prof.

Macdonell's "History of Sanskrit Literature":

"Turning to Philosophical Literature, we find that the early Greek and Indian Philosophers have many points in common. Some of the leading doctrines of the Eleatics, that God and the universe are one, that everything existing in multiplicity has no reality, that thinking and being are identical, are all to be found in the philosophy of the Upanishads and the Vedânta system, which is its outcome. Again, the doctrine of Empedocles, that nothing can arise which has not existed before, and that nothing existing can be annihilated, has its exact parallel in the characteristic doctrine of the Sâ*m*khya system about the eternity and indestructibility of matter. According to Greek tradition, Thales, Empedocles, Anaxagoras, Democritus, and others undertook journeys to Oriental countries in order to study philosophy. Hence there is at least the historical possibility of the Greeks having been influenced by Indian thought through Persia.

"Whatever may be the truth in the cases just mentioned, the dependence of Pythagoras on Indian philosophy and science certainly seems to have a high degree of probability. Almost all the doctrines ascribed to him, religious, philoso-

phical, mathematical were known in India in the sixth century B. C. The coincidences are so numerous that their cumulative force becomes considerable. The transmigration theory, the assumption of five elements the Pythagorean theorem in geometry, the prohibition as to eating beans, the religio-philosophical character of the Pythagorean fraternity and the mystical speculations of the Pythagorean school, all have their close parallels in ancient India. The doctrine of metempsychosis in the case of Pythagoras appears without any connection or explanatory background and was regarded by the Greeks as of foreign origin. He could not have derived it from Egypt, as it was not known to the ancient Egyptians. In spite, however, of the later tradition, it seems impossible that Pythagoras should have made his way to India at so early a date, but he could quite well have met Indians in Persia."[1]

(1) "History of Sanskrit Literature" pp. 421—22. Colebrooke himself sums up his views in these words :—"I should be disposed to conclude that the Indians were in this instance teachers than learners." "Trans. Roy. As. Soc.," Vol. 1., p. 579. Prof. H. H. Wilson observes :—"that the Hindus derived any of their philosophical ideas from the Greek seems very improbable, and if there is any borrowing in the case, the latter were most probably indebted to the former." Preface to the Sámkhya Káriká (1837) p. ix.

CHAPTER II

Chemistry in the Charaka and the Sus'ruta

THE CHARAKA

[The subject-matter in the first few extracts in this chapter is practically based upon the Vaiseshika system ; see ante pp. *6 et seq.*]

THE TASTES—THE METALS AND THEIR CALCES

"The object of the tongue is taste. Water and earth are the objective existences in which taste inheres. In its manifestation and as regards particular kinds of it, space, air and light are also its adjuncts. Sweet, sour, salt, pungent, bitter and astringent, these are regarded as the sixfold catalogue of tastes. * * * Objects are again known to be of three kinds, *viz.*, animal products, vegetable products and products appertaining to the earth. Honey, vaccine, secretions, bile, fat, marrow, blood, flesh, excreta, urine, skin, semen, bones, tendons, horns, nails, hoofs, hair, bristles and

the bright pigment called *Gorochanā*,[1] are used (as drugs) among animal products. Gold, the five metals and their ordure [*i.e.* their calces, the five metals *viz.*, silver, copper lead, tin and iron], sand, lime, red arsenic, gems, salt, red chalk and antimony, are indicated as drugs appertaining to the earth."[2]

A Discourse on the Tastes—their Relationship to the five Primal Elements—the Nature of the Alkali

"Once on a time, the son of Atri, and Bhadrakāpyas *S*ākuntèya and the full-eyed Maudgalya, and the golden-eyed Kau*s*ika, the sinless Bharadvāja otherwise called Kumāra*s*iras, the blessed king Vāryovida, that foremost of all intelligent men Nimi, the ruler of the Vi*d*ehas, Va*d*i*s*a of high intelligence, and Kā*m*khāyana-vālhīka, that foremost of all physicians of the Vālhīka country,—these *Ri*shis, all of whom were old in years and learning and all of whom had subjugated their souls, came together to the delightful Chaitraratha woods, desirous of passing a few days in enjoyment

(1) Concretions found in the gall bladder of the ox.

(2) A. C. Kaviratna's Translation of "Charaka Samhitā," pp. 6-7.

and pleasure. As those *Ri*shis conversant with every topic were seated there, the following discourse of grave import took place among them on the subject of the proper ascertainment of the (different) tastes and food.

"There is one kind of taste said Bhadrakāpya; which persons skilled in the subject regard as are of the five subjects of the senses, *viz.*, that which relates to the tongue. That, again, is not different from water.

"The Brāhmaṇa Śākuntêya said there are two tastes, their virtues being that one of them cuts or removes from the body all bad humours or ingredients, and the other only checks or curbs them.

"There are three tastes, said the full-eyed Maudgalya. Their virtues are cutting, curbing, and both.

"There are four tastes, said the golden-eyed Kauśika. They are agreeable and beneficial, and agreeable and non-beneficial, disagreeable and beneficial.

"There are five tastes, said Kumāraśira-Bharadvāja. They appertain to Earth, Water, Fire, Air and Ether (or Space).

"There are six tastes, said the royal sage

Vāryovida. They are heavy, light, cold, hot, oily and dry.

"There are seven tastes, said Nimi, the ruler of the Videhas They are sweet, sour, saltish, pungent, bitter, astringent and alkaline.

"There are eight tastes, said Va*d*isa-Dhāmārgava. They are sweet, sour, saltish, pungent, bitter, astringent, alkaline and that which remains in an unmanifest form.

"The tastes are infinite in number, said Kā*m*-khāyana, foremost among the physicians of the Vālhīka country in consequence of the infinite variety of their virtues, operations or effects and methods of corrections (or mixture for adding to their virtues, etc.,).

"The illustrious son of Atri, *viz.*, Punarvasu, said that the number of tastes is truly six. They are sweet, sour, saltish, pungent, bitter and astringent. The source from which these six flow, *i. e.* their origin, is water. Their operations or effects are of two kinds, viz., cutting and curbing. In consequence, again, of mixture or combination, they become both cutting and curbing at the same time. Agreeable and disagreeable are their divisions that depend upon the likes and dislikes of men. Beneficial and non-beneficial are their

powers. The refuge of the tastes are the modifications of the five primal elements (of Earth, Water, Fire, Air and Ether or Space). The tastes, again, depend upon the (original) nature of their refuge, the modifications of that refuge, combinations of the substances that form their refuge, as also place, and time.[1]

"The virtues or properties (attaching to the tastes) occur in those which constitute the refuge (of the tastes), called objects. Those virtues are heavy, light, cold, warm, oily, dry and others.

"*Kshāra* (alkali) is so called from its being produced by *ksharana* (dropping down or straining). This is not a taste. It is, on the other hand, an object. It is, in fact, produced from many kinds of taste. Hence, it has many tastes. Among them, pungent and saline predominate. It is composed of many objects of the senses. It is manufactured with the aid of different processes.

* * * * *

(1) The modifications of the five primal elements constitute the refuge of the tastes. Every substance is formed by modifications of those elements. What is said, therefore, is that material substances are the refuge of the tastes, *i.e.* the tastes inhere in them.

"At the outset, however, we shall say something referring to the diversity of objects (which are the refuse of the tastes). All objects are the results of the combinations of five primal elements (*viz.*, Earth, Water, Fire, Air and Ether or Space). As regards Medical Science, object are of two kinds, *viz.*, those endowed with animation and those that are inanimate. The attributes which inhere in objects are sound, &c., heaviness &c., ending with solubility."[1]

We now quote only a few typical instances of mineral and metallic preparations.

The Five Kinds of Salts

"The five kinds of salts *viz.*, sauvarchala, saindhava, vit, audbhida, with sāmudra." [See Index under the respective headings].

Minerals for External Application

"Sulphate of copper, sulphate of iron, realgar, orpiment and sulphur in combination with vegetable drugs are prescribed for external application in ringworm, eczema, leprosy, &c.,"[2]

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(1) Kaviratna's Trans., pp. 295-99.

(2) Sūtra, Ch. III, 4-5.

The Eight Varieties of Urine

"The eight varieties of urine are those of the sheep, the goat, the cow, the buffalo, the elephant, the camel, the horse and the ass." [1]

Preparation of Kshāra (alkali)

"A young *butea frondosa* is to be cut to pieces and dried and finally reduced to ashes. The ash is to be lixiviated with four or six times its weight of water and strained (through linen) 21 times."[2]

Pill Iron Compound

"Into the composition of pill iron compound pyrites and the rust of iron enter." [3]

A Collyrium

"The ingredients of a collyrium are conch-shell, coral, lapis lazuli, iron, copper, the bone of the

(1) Ibid, Ch. I, 43.
(2) Chikitsā, Ch. XXIII, 26.
(3) Ibid, Ch., XVI 28.

frog, sulphide of antimony and the seed *hyperanthera morunga.*"[1]

[The first five articles are interpreted as meaning the calces thereof.]

Powder of Pearl Compound

"Among the constituents we have, pearl, sulphur, powder of iron, copper and silver."[2]

[The text does not precisely say whether the metals are to be used *as such* or *as killed* by being roasted with sulphur. The Hindu physicians however always take them in the latter sense.]

Iron, Gold and Silver Tonics

"A thin iron plate is to be made red hot and plunged into the decoction of the myrobalans, cow's urine, the solution of 'the salts", the solution of the alkali extracted from the ash of *butea frondosa*; *i.e.* made red hot and plunged into one of the above liquids at a time. When the iron becomes black like collyrium it is to be powdered. * * *

(1) Ibid, Ch, XXVI, 123.

(2) Chikitsá, Ch. XVII, 40.

The references are according to the edition of Kavirajes D. N. Sen and U. N. Sen.

"The same process to be adopted in the case of gold and silver."[1]

Rasāyana Defined

"Medicines are of two kinds: the one promotes the strength and vitality of the healthy, the other cures diseases.

'Whatever promotes longevity, retentive memory, health, virility, &c. is called Rasāyana."[2]

THE SUSRUTA

Preparation and Use of Alkalies and Alkaline Caustics.[3]

"Of all cutting instruments and accessory cutting instruments, caustics are superior inasmuch as they perform the work of incisions, punctures and scarifications, relieve derangements of the three humours, *viz.*, air, bile and phlegm, and uniformly affect the diseased part to which they are applied. *Kshāra* (caustics) are so called

(1) Chikitsā Ch. I. 5. pp. 497-98.

(2) Ibid Ch. I. pp. 2-6.

(3) We have adopted Udoy Chand Dutta's Translation of Chs. XI and XIV with certain corrections here and there.

because they remove diseased parts and destroy the skin and flesh. From being composed of numerous medicines they can affect the three humours. Caustics being white in colour are cooling or of lunar origin.[1] This origin is not inconsistent with their burning, escharotic and lacerating properties. Being composed of numerous heating medicines, caustics are acrid, hot and pungent. They promote suppuration, destroy parts, improve unhealthy sores and promote granulation, dry up discharge, stop bleeding and abrade the skin. Their internal use removes worms, acidity, phlegm, skin diseases, some poisons and corpulence. Their excessive use causes impotence.

" Alkalies are of two sorts, namely, for external application and internal administration. They are used externally in the skin diseases called *kustha*, in keloid, ringworm leucoderma, lepra, fistula-in-ano, tumours, unhealthy ulcers, sinuses, condyloma, moles, chloasma, brown spots on the face, warts, external inflammations, worms, poisons and piles, and in the seven following diseases of the mouth

(1) The reader will not fail to notice that silver nitrate is, in the language of Western Alchemy, named *lunar caustic.*

namely, *upajihvā* (ranula), *adhijihvā* (tumour on the tongue), *upakusa* (inflammation of the gum), *danta-vaidarbha* (inflammation of the gum from injury), and the three sorts of rohinī or inflammation of the throat. In these diseases of the mouth, accessory instruments, in the shape of caustics only, should be used. Alkaline solutions are administered internally in chronic or slow poisoning, abdominal tumours, ascites, loss of appetite, indigestion, disinclination for food, tympanitis, urinary deposits, calculi, internal or deep-seated inflammation, intestinal worms, poisoning and piles. Alkalies do not agree with children, old and weak people, and persons having a tendency to hœmorrhage from internal organs, or a bilious temperament. They are injurious in fever, giddiness, intoxication, fainting, amaurosis and such other diseases.

"Alkalies for escharotic use are prepared like other alkalies by straining alkaline solutions as elsewhere explained in detail. They are made of three strengths, namely, weak, moderate and strong. He who wishes to prepare alkalies should in an auspicious day in autumn, fasting and in pure body, select a middle-aged, large-sized, uninjured *ghantāpātalī* tree with black flowers (*Schrebera swietenioides*) growing on an approved spot on a mountain, and

address it with certain *mantras* or incantations as a preliminary ceremony called *adhivāsa*. Next day the tree should be cut or killed after reciting the following *mantra* or prayer: "Oh you with great fiery power may not thy strength be lost! Oh you auspicious tree, stay here and accomplish my work. After accomplishing my work you will go to heaven." Then the ceremony of *homa*, or burning the sacrificial fire, should be performed with one hundred red flowers. The tree should then be cut to pieces and piled in a place free from wind. Some limestone should be placed on the pile which should be set on fire by stalks of *Sesamum Indicum*. When the fire is extinguished, the ashes of the *ghantāpātali* tree and the burnt lime should be kept separate. In the same way the following trees may be burnt with their root, branches, leaves and fruits for the preparation of alkalies,[1] namely:

Kuṭaja	Hollarrhena antidysenterica.
Palāśa	Butea frondosa.
Aśvakarṇa	Shorea robusta.
Pāribhadraka	Erythrina indica.
Vibhitaka	Terminalia bellarica.

(1) Cf. Rasārṇava, below, where the standard "plant ashes" are enumerated.

Âragvadha	Cassia fistula.
Tilvaka	Symplocos racemosa.
Arka	Calotropis gigantea.
Snuhî	Euphorbia neriifolia.
Apâmârga	Achyranthes aspera.
Pâtalâ	Stereospermum suaveolens.
Naktamâla	Pongamia glabra.
Vrîsha	Justicia adhatoda.
Kadalî	Musa sapientum.
Chitraka	Plumbago zeylanica.
Pûtika	Guilandina bonducella.
Indravriksha	Terminalia arjuna.
Âsphota	Salvadora persica.
Asvamâraka	Nerium odorum.
Saptachchhada	Alstonia scholaris.
Agni mantha	Premna serratifolia.
Gunjâ	Abrus precatorins.

4 sorts of Kosâ 4 varieties of Luffa amara."

LIXIVIATION OF THE ASHES

"Thirty two seers of ashes should be stirred or mixed with six times their quantity of water or cow's urine and the mixture strained through cloth. This should be repeated twenty-one times. The strained fluid should then be boiled slowly in a large pan and agitated with a ladle. When the fluid becomes clear,

pungent and soapy to the feel, it should be removed from the fire and strained through cloth. The filtrate[1] being thrown away, the strained fluid should be again boiled. From this alkaline solution take three quarters of a seer."

RENDERING THE ALKALI CAUSTIC

"Then take eight palas each of Banduc nut, burnt limestone, conch shells, and bivalve shells and heat them in an iron pan till they are of the colour of fire. Then moisten them in the same vessel with the above-mentioned three-quarters of a seer of alkaline water and reduce them to powder. This powder should be thrown on sixty-four seers of the alkaline water and boi ed with constant and careful agitation by the ladle. Care should be taken that the solution is neither too thick nor thin."

HOW TO STORE UP THE ALKALI

"When reduced to proper consistence, the solution should be removed from the fire and poured into an iron jar. The opening or mouth of

(1) This is evidently a mistake. According to the original text, it should be "the dregs" *i. e.* the precipitate.

the jar should be covered, and should be kept in a secluded place. This preparation is called *madhyama* kshāra or alkaline caustic of middling strength. When the alkaline water is simply boiled to the proper consistence without the addition of burnt shells, &c., the preparation is called *mridu*[1] kshāra or weak alkaline solution. The strong alkaline caustic is prepared by boiling the weak solution with two tolahs each in fine powder of such of the under-mentioned ingredients as are available, namely :—

Dantī,	Baliospermun montanum.
Dravantī	Salvinia cucullata.
Chitraka	Plumbago zeylanica.
Lāngalikī	Gloriosa superba.
Pūtika	Guilandina bonducell.
Kanaka	Salvinia cucullata.
Kshīrī	Cleome felina.
Vachā	Acorus calamus.

"Aconite root, carbonate of soda, asafœtida, black salt and corals.

"This solution is used for bringing to a head or opening abscesses. These three varieties of alka-

(1) "Mridu" may be rendered more accurately as "mild."

lies should be used according to the state of the disease. In weak persons, the alkaline water without the addition of other caustic ingredients, should be applied to strengthen the parts."

Characteristics of the Good and the Bad Alkali

On this subject there are the following verses:

"Good alkaline caustics should be neither too strong nor too weak. They should be white in colour, smooth and soapy to the touch, should not spread beyond where they are applied, and act rapidly and successfully. These are the eight good properties of caustics. Their bad qualities consist in their being too weak or cool, too strong or hot too slippery and spreading, too thick or too underboiled, or they may be deficient in ingredients.

"In applying caustic to a patient suffering from a disease curable by this remedy, he should be made to sit in a spacious place, protected from wind and sun. The physician should then procure the instruments or necessary articles according to the rules laid down in the fifth chapter. He should then examine the diseased part, rub, scarify or scratch it, and then apply the caustic by means of a probe, and

wait for the space of time required to utter one hundred words. The diseased part turns black on the application of the caustic which is a sign of its having been burnt. The application of some acid mixed with clarified butter or honey relieves the pain. If from the thickness of the burnt part, it does not fall off, the following application should be thoroughly applied to it, namely, equal parts of tamarind pulp, of the refuse of *kānjika* (fermented rice water i. e. crude vinegar), sesamum seeds and liquorice root rubbed together into a paste. Sesamum seeds and liquorice root rubbed together with clarified butter promotes granulation in ulcers."

Why the Acid Neutralises the Alkali

"If you question, my son! how is it that the application of the pungent acid of *kānjika* relieves the burning of the fire-like hot alkaline caustic, then hear the following explanation from me. Alkalies possess all the tastes except that of the acid. The acrid taste prevails in it and the saline one to a less degree (cf. *ante* p. 28). The sharp saline taste when mixed with acid becomes very mild, and gives up its sharp quality. From this modification of the saline taste, the pain of caustics is relieved just as fire is extinguished by water."

MILD AND CAUSTIC ALKALIES

It will be noticed that there is a distinct mention of "mild" and "caustic" alkalies in the body of the text. The process of lixiviating the ashes and rendering the lye caustic by the addition of lime leaves very little to improve upon, and appears almost scientific compared to the crude method to which M. Berthelot pays a high tribute:

"Fabrication de la Lessive:—Quatre muids de cendres sont répartis entre deux cuviers, percés de trous au fond. Autour du trou le plus petit, du côté intérieur, mets une petite quantité de foin, pour que la cendre n'obstrue pas le trou. Remplis d'eau le premier des cuviers; recueille le liquide filtré qui en découle pendant toute la nuit et mets-le dans le second cuvier; grade ce qui filtere de ce second cuvier. Mets d'autre cendre (dans un troisième cuvier). Epiuse-la et il se forme une liqueur pareille au nard couleur d'or. Verse-la dans un quatrième cuvier. La liqueur devient piquante et forte: telle-est la lessive particulière." "Coll. d. Alch. Grecs" III. trad. p. 357.

We reproduce the remarks of M. Berthelot on the above: "On a regardé comme modernes les procédés de lixiviation méthodique, usités pour

exprimer les cendres et les matériaux salpêtrés: le passage suivant, tiré du manuscrit de Saint-Marc, montre que ces procédés remontent au XIe siècle et sans doute au delà."-" Chimie des Anciens" p. 284.

DESCRIPTION OF BLOOD
(Chapter XIV of Sūtrasthānam)

"The four varieties of food derived from the five elements and having the six tastes, the two properties of heat and cold or according to some, eight properties and many qualtities when taken in moderation and thoroughly digested, produces a fine substance imbued with energy and fire. This is called *rasa* (chyle). The heart is the seat of the *rasa* or chyle. From the heart it proceeds through 24 arteries, namely, ten ascending, ten descending, and four transverse to all parts of the body. By some unseen cause or destiny, this chyle continually satiates, increases, nourishes and supports the body and keeps it alive. The motion of this chyle throughout the body is inferred form the processes of decline, increase, and diseased condition of the different portions of the body. It may be asked whether this chyle which pervades all the external parts of the body, the three humours, the tissues,

including the blood and the receptacles of the secretions, is endowed with the property of heat or cold. As this chyle is a circulating fluid, and as it softens, vitalises, supports and nourishes the body, it should be known to possess the cooling property. This watery fluid no doubt assumes a red colour in the liver and spleen, that is, it is converted into blood in these organs. On this subject there is the following verse:

"The *rasa* (chyle) of living beings is coloured red by healthy bile. This coloured fluid is called blood. The blood excreted by women and called the menstrual fluid is derived also from this *rasa*. This menstruation, coming at the age of twelve, ceases at the age of fifty.

"The menstrual fluid is endowed with the property of heat, owing to the womb being possessed of both the properties of heat and cold. Other writers say that the blood of living beings is composed of the five elements. The five qualities of the five elements as seen in blood are as follows, namely, fleshy smell, liquidity, red colour, tendency to trickle or ooze, and lightness.[1] Blood is produced

(1) Cf. *ante* pp. 6-7 under Vaiseshika Philosopy.

from chyle, flesh from blood, fat from flesh, bones from fat, marrow from bones, and lastly the semen is produced from marrow. The chyle produced from food and drink nourishes these constituent parts of the body. Living beings are produced from the *rasa*; hence sensible people should carefully preserve this *rasa* by conforming to the proper rules of diet and regimen."[1]

On the Collection of Drugs

(Chapter XXXVIII : Sūtrashānam)

37 classes of vegetable drugs are mentioned which chiefly constitute the Materia Medica. There is only one *s*loka in which the six metals *viz.*, tin, lead, copper, silver, krish*n*aloha (iron) and gold, and their calces are recommended.

The Salts

Rock-salt, sea-salt, bit, sauvarchala, romaka and audbhid, &c. (see *ante* p. 29).

(1) The reader may compare the above theories on the Chemistry and Physiology of Digestion and Nutrition with those of Geber. *Vide* "Traité d'Alchimie Arabe," trad. pp. 201-3.

THE ALKALIES

Yavakshāra (factitious carbonate of potash), sārjikākshāra[1] (trona or natron); the alkaline solution prepared according to directions given in Ch. XI; and borax.

Internal administration of alkali is recommended for dissolving the stones or gravels (urinary calculi).

INTERNAL USE OF LEAD AND TIN

Lead and tin are described as vermifuge—a property also accepted by the later Iatro-chemists.

Powdered tin rubbed for seven days together with the creamy portion of curd is recommended for internal administration.

MINERALS FOR EXTERNAL APPLICATION

For the treatment of ulcer an external application of sulphate of copper, sulphate of iron, orpiment and realgar, &c., is prescribed.

(1) From the time of the Charaka and the Susruta, Hindu Pharmacy has always recognised these two alkalies as distinct.

Another recipe includes alum-earth, red-ochre, sulphate of copper, yellowish (basic) sulphate of iron, rock-salt, orpiment and realgar. [1]

ROASTING OF IRON AND OTHER METALS, SO AS TO RENDER THEM FIT FOR INTERNAL ADMINISTRATION.

Thin leaves of cast iron are to be smeared with the levigated powder of "the salt" and heated in the fire of the cow-dung cakes and then plunged into a decoction of the myrobalans and asafœtida. This process is to be repeated 16 times. The leaves are then to be ignited in the fire of the wood of *mimosa catechu* and afterwards finely powdered and passed through linen of fine texture.

The above process is equally applicable to the roasting of the other metals. [2]

THE ORIGIN OF BITUMEN

The origin of bitumen is much the same as in the Charaka and the Bower Ms.; the only difference

(1) Chikitsitasthánam Ch. XIX, 37, ed. J. Vidyáságara.
(2) See Note on the "Metals and their Salts" p. 48

being that, according to Susruta, bitumen is related to six instead of four metals (see below p. 53).

Iron Pyrites

Iron Pyrites are collected on the bank of the river Tāpī, of the lustre of gold and silver respectively (see below under "Rasaratnasamuchchaya", Bk. II, 77-81 and prescribed in the treatments of diabetes, leprosy, &c.

Gold Dust

Gold dust, mixed with lotus seed, honey, &c. is used as a tonic.

The Poisons

The Poisons are classified as animal, vegetable and mineral respectively. Under the last we have *Phenasma bhasma*[1] and orpiment.

(1) It is sometimes taken to mean white arsenic; "but it is very doubtful if Susruta meant any native white arsenic by it. The derivation of the term implies that it was obtained by roasting some sort of stone or ore." Dutt.

USE OF MERCURY

The only references to mercury, which are however very vague, are सारः सुतारः ससुरेन्द्रगोपः सर्वे च तुल्याः कृमिश्च नाम: , and : रक्तं श्वेतं चन्दनं पारदञ्च काकोल्यादिः क्षीरपिष्टश्च वर्गः ।

NOTE ON THE METALS AND THEIR SALTS (अयःस्कृति) [1]

Six metals are recognised, namely: tin, iron, lead, copper, silver and gold.[2] The thin leaves of the metals by being plastered over with a paste of "the salts" (see p. 46) including common salt, salt-petre and sulphate of magnesia and afterwards subjected to roasting were no doubt converted into their respective oxides, chlorides or oxychlorides as the case may be. We have thus in

(1) अत ऊर्द्धमयस्कृतीर्व्याख्यास्यामः । तीक्ष्णलोहपत्राणि तनूनि लवणवर्गप्रदिग्धानि गोमयाग्निप्रतप्तानि * * * सूक्ष्मचूर्णानि कारयेत् । Chikit., Ch. X, 9.

(2) त्रप्वादीनान्तु लोहानां यथाक्रमं Chikit., Ch. XIII, 3.

त्रपुसीसताम्ररजतकृष्णलोहसुवर्णानि । Sûtra., Ch., XXXVIII, 56.

the Susruta a crude and imperfect, but all the same *potentially modern*, process for the preparation of the metallic salts. The much reputed "potable gold" in the shape of the chloride of the metal was probably in this way obtained. It will be interesting to note the successive stages in the evolution of the chemical processes as we proceed. (See below especially under "Chemistry in Rasārnava," where the mixture of the salts is technically named "vida" and consists of green vitriol, alum, common salt, salt-petre, &c.).

The reader will find an analogy in the ancient Egyptian and Greek methods as preserved in the Leyden Parchment, one or two extracts from which cannot fail to be of interest. It may be added by way of explanation that mineral acids being unknown to the ancients they had often to take recourse to the roundabout way of heating metals in combination with a mixture of blue vitriol, copperas, common salt and so on (see under "Mineral Acids") in order to get their salts.

"Ayant pris quatre paillettes d'or, faites-en une lame, chauffez-la et trempez-la dans de la couperose broyée avec de l'eau et avec une autre (couperose) sèche, battez (une partie)...une autre avec la matière mélangée: déversez la rouille et jetez dans..."

4

"Il y a là deux recettes distinctes. Dans toutes deux figure le sulfate de cuivre plus ou moins ferrugineux, sous les noms de *chalcanthon* ou couperose et de sory. La seconde recette semble un fragment mutilé d'une formule plus étendue. La première présente une grande ressemblance avec une formule donnée dans Pline pour préparer un remède avec l'or, en communiquant aux objects torréfiés avec lui une propriété spécifique active, désignée par Pline sous nom de *virus* * * * ...ce qui complète le rapprochement entre la formule de Pline et celle du papyrus. Voici les paroles de Pline :

"On torréfie l'or dans un vase de terre, avex deux fois son poids de sel et trois fois son poids de misy ; puis on répète l'opération avec 2 parties de sel et 1 partie de la pierre appelée schiste. De cette facon, il donne des propriétés actives aux substances chauffées avec lui, tout en demeurant pur et intact. Le résidu est une cendre que l'on conserve dans un vase de terre."

"Pline ajoute que l'on emploie ce résidu comme remède. L'efficacité de l'or, le plus parfait des corps, contre les maladies et contre les malfices est un vieux préjugé. De là, au moyen âge, l'idée de l'or potable. La préparation indiquée par Pline

devait contenir less métaux étrangers à l'or, sous forme de chlorures ou d'oxychlorures. Renfermait-elle aussi un sel d'or? A la rigueur, il se pourrait que le chlorure de sodium, en présence des sels basiques de peroxyde de fer, ou même du bioxyde de cuivre, dègageât du chlore, susceptible d'attaquer l'or métallique ou allié, en formant du chlorure d'or, ou plutôt un chlorure double de ce métal. Mais la chose n'est pas demontrée. En tous cas, l'or se trouve affiné dans l'opération précédente."[1]

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(1) "Coll. des Anciens Alch. Grecs," Vol. I., pp. 14-15.

CHAPTER III

Chemistry in the Bower Ms.

THE ALKALIES

The alkalies in the Bower Ms. are the two carbonates of potash and soda. (Yavakshāra and Sarjikākshāra)

FUMES OF HORN

The fumes of horn are recommended as giving relief in hiccough. [Practically the same as "spirits of hartshorn."]

KSHĀRATAILA

"Oil, boiled with the ashes of long pepper, is a remedy for ear diseases" (Pt. ii. fasc. ii. p. 131). [Cf. The formula given in Chakrapā*n*i (see p. 63)]

FORMULA FOR HAÍR-DYE

Sulphates of copper and iron, boiled with the oil of belleric myrobalans * * * are used as a

remedy for turning grey hair into black (ibid; p. 162).

Rasayana Defined

It is called Rasāyana because it has a beneficial effect on *Rasa* or chyle and other elements of the body. Cf. p. 32.

The Doctrine of Bitumen[1]

Bitumen is produced from the following four metals: Gold, copper, silver and iron. Gold and other metals in the mountains, when heated by the sun, emit their impurities, oil-like, heavy and clay-like: these are the bitumen.

A Linctus

With certain vegetable drugs and "riparian sulphide of antimony,"[2] a linctus is made up with honey into a paste. (Pt. ii. fasc. 11. p. 123)

(1) The whole of this chapter, in a practically identical recension, is found in the Charaka. See Bower Ms., Pt. II., fasc. ii., ch. xii., p. 167.

(2) Srotaja anjana; it is one of the five kinds of anjana or substances used for collyriums. The word literally means produced from a river, especially from the Yamuna. See Garbe's "Indische Mineralien," p. 54.

FORMULÆ FOR EYE-OINTMENT

Red ochre, rasôt, galena, realgar, calx of brass (रीतिकुसुम) in equal parts...

With pepper and calx (of brass) one should boil gold on a slow fire together with clarified butter.[1]

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(2) The Bower Ms., Pt. I., verses 110 and 166.

CHAPTER IV

Chemistry in the Vagbhata.

A typical example is contained in the following recipe:

Sulphate of copper, red ochre, realgar, orpiment sulphate of iron, &c., are recommended for external application for genital sores.

PREPARATIONS OF GOLD, SILVER, COPPER, IRON AND LEAD

Gold, copper, silver, iron or tin are to be taken with the myrobalans, rock-salt and honey, &c.

Gold, silver, copper and iron are to be taken in conjunction with bitumen and milk.

Take 64 parts of stibium[1] and one part each of

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(1) " "स्रोतोञ्जन" " Srotonjana is evidently stibnite or the native sulphide of antimony (See p. 53); Dutt translates it, we know not on what grounds, as calx-spar.

copper, iron, silver and gold; now roast them in a closed crucible, &c.[1]

Take 30 parts of lead, 5 parts of sulphur, 2 parts of copper and orpiment each, 1 part of tin and 3 parts of stibium. Now roast them in a closed crucible.[2]

[Here as well as in the preceding *sloka*, we have distinct mention of अन्धमूषा or a *crucible with the lid on*. This is one of the preparations which can be brought into line with those of the Tāntric and Iatro-chemical periods.]

Preparation of Alkali and Caustic Alkali[3]

[As Vāgbhaṭa borrows his method of preparation of alkali almost word for word from Susruta, it is quite superfluous to reproduce it here.]

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(1) Uttarasthánam, Ch. XIII, p. 20-21.

(2) Ibid, Ch. XIII, p. 31-32.

(3) Sútra., Ch. XXX.

USE OF MERCURY

Take equal parts of mercury and lead and make them up into a collyrium with their equal weight of stibium and camphor.[1] [This is perhaps the only instance in which the mention of mercury is found.]

(1) "Uttarasthánam," Ch. XIII, 36. This very formula, with but slight variations, occurs also in Rasaratnasamuchchaya, Ch. xxiii, 46.

The Transitional Period

(From 800 A.D. to circa 1100 A.D.)

Chemistry in the Siddha Yoga of Vrinda and in Chakrapani

CHAPTER I

VRINDA

(*Circa 900 A. D.*)

PREPARATIONS IN WHICH SULPHIDE OF COPPER AND ÆTHIOPS MINERAL FIGURE

Sulphur, copper and the pyrites are to be pounded together with mercury and subjected to roasting in a closed crucible and the product thus obtained to be administered with honey. This is known as "parpati tāmra*m*.[1]"

(1) This preparation does not occur in the Poona edition, but is to be found in the Kāsmīr Ms. under रसायनाधिकार,

Take one part of sulphur and half its weight of mercury [The components to be rubbed together.] ....The same to be administered with honey and clarified butter. This is called "rasāmrita chūrnam.[1]"

Quicksilver, rubbed with the juice of *dhatura s.* or *piper betle*, and applied externally, kills lice. (Poona ed. p. 122.)

A COLLYRIUM

Compounded of 14 ingredients amongst which occur the belleric myrobalans, rock-salt, *killed* copper and blue vitriol—all in the powdered form. (Poona edition, p. 470.)

This very preparation, in identical recension, occurs in Chakrapāni under the name of "Nāgārjuna Varti."

A PROCESS OF KILLING IRON

The, text which occurs only in the Kāsmīr Ms. under रसायनाधिकारः । unfortunately in a mutilated from, would seem to indicate that the iron is

(1) *Vide* Kásmír Ms. under पञ्चविंशाधिकारः, omitted in the Poona edition.

to be first ignited in the fire and then macerated in the juice of the emblic myrobalan, and *trewia nudiflora* and exposed to the sun, and again to be macerated in the juice of certain other plants and then to be rubbed in a mortar.

CHAPTER II

CHAKRAPANI

(Circa 1060 A. D.)

Black Sulphide of Mercury (Kajjali)

or

Æthiops Mineral

The first process consists in the purification of mercury.

"Quicksilver, rubbed repeatedly in the juice expressed from *sesbania aculeata, ricinus communis, zingiber* and *solanum nigrum*, becomes purified."

"Take one part of mercury and one part of sulphur, rub the two together in a mortar and thus prepare *kajjali* or *rasaparpati*.[1]"

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(1) Chakrapáni himself claims its discovery or at any rate its introduction : रसपर्पटिका ख्याता निबद्धा चक्रपाणिना । *Vrinda*, however, recommends its use as well.

TAMRAYOGA (LIT. POWDER OF COPPER COMPOUND)

"Take a thin leaf of Nepalese copper and embed it in powdered sulphur. The substances are to be placed inside a saucer-shaped earthen-ware vessel and covered with another. The rims are luted with sugar or powdered rice-paste. The apparatus is heated in a sand-bath for three hours. The copper thus prepared is pounded and administered with other drugs."

PROCESS OF KILLING IRON

"I shall now describe the science of iron as promulgated by the sage Nāgārjuna." [A tedious process given with wearisome minutiæ of which the substance only is reproduced below.]

A bar of iron is to be rubbed with the levigated powder of the following vegetable products among others: the belleric myrobalans, *clitoria ternatea*, *vitis quadrangularis*, *boharhaavia diffusa* and *verbesina calend.* It is then strongly heated to the fusion point and plunged into the decoction o the myrobalans. The iron is then powdered by being beaten with an iron hammer. The powder

is then digested in the decoction of the myrobalans and roasted repeatedly in a crucible.

Mandūra or Rust of Iron.

Rust of iron is prescribed in combination with other drugs.

Recipe for a Soap to be used as a Depilatory.

The ashes of *schrebera swiet.* and *cassia fist.* are to be mixed with lime from burnt shells and lixiviated with the urine of the ass. The lye is then to be boiled with a definite weight of mustard oil.

Preparation of Caustic Alkali

[Much the same as in the Susruta]

Calx of Silver

In a preparation named "yogarāja" रूप्यभस्म or calx of silver (probably in the shape of sulphide) figures as a component.

The Tantric Period

(From 1000 A. D. to circa 1300 A.D.

CHAPTER I

Chemistry in Rasarnava

[In Rasārṇava, as in all other Tantras, knowledge is imparted in the shape of a dialogue between Bhairava (*S*iva) and his consort Pārvatī.]

EXTRACTS FROM BOOK IV—ON APPARATUS AND THE COLOUR OF FLAMES

Sri Bhairava said :

"The rasas, the uparasas (see p. 79), the metals, a piece of cloth, viḍam (see p. 72), a pair of bellows, iron implements, stone pestles and mortars, the apparatus known as Koshṭī (see p. 69), mouth blow pipe * * cow-dung, substantial wood (as fuel), various kinds of earthen apparatus (*e. g.* crucibles &c.), a pair of tongs and earthen and iron vessels, weights and balances, bamboo and iron

pipes, the fats, the acids, the salts and the alkalies, the poisons—all those are to be collected and chemical operations begun."

DOLA YANTRAM

As R. R. S.[1] borrows the description of this apparatus *verbatim*, it is unnecessary to repeat it here.[2]

AN APPARATUS FOR KILLING METALS

"Make two iron crucibles each 12 digits in length, the one with a narrow orifice containing sulphur is inserted into the other holding mercury; below the mercury is placed water [in a separate vessel]. The mercury and the sulphur should be carefully moistened in garlic juice, which has been filtered through a cloth. The apparatus is now lodged in an earthen pot and another placed over it, the rims being luted with cloth previously smeared with earth * * now cow-dung fire is urged. After continuing heating for three days

(1) R. R. S. is the abbreviation for 'Rasaratnasamuchchaya."
(2) See Book ix. of R. R. S.

the apparatus is taken out." [This description, in almost identical recension, occurs in R. R. S. under the name of [illegible]. The language is faulty and the meaning not very clear.]

Garbha Yantram

"I shall now describe the Garbha Yantram for reducing *pistikā*[1] to ashes. Make a crucible 4 digits in length, and 3 digits in width, with its mouth rounded. Take 20 parts of salt and one of bdellium and pound them finely, adding water frequently; rub the crucible with this mixture. * * Make a fire of paddy husks and apply gentle heat. In the course of one to three days the mercury is reduced to ashes." [*Vide* Illustrations.]

Efficacy of the Apparatus

"For killing and colouring mercury, an apparatus is indeed a power. Without the use of

(1) A cake of mercury and sulphur.

herbs and drugs, mercury can be killed with the aid of an apparatus alone; hence an expert must not disparage the efficacy of the apparatus."

Ha*m*sapāka Yantra*m*

"Take an earthen dish and fill it with sand and place another over it; apply gentle heat. Now digest in this apparatus [the ingredients] with the five alkalies (cf. pp. 45 and 69), the urines (see p. 30), and the "vi*d*a" (see p. 72). This is known as Ha*m*sapāka Yantra*m* by the adepts."[1]

Crucibles

"Earth of black red, yellow and white colour * * burnt husks of paddy, soot, earth from the ant-hill, well burnt excrements of the goat and the horse * * rust of iron" * * [varying proportions of the above ingredients are used for making crucibles, retorts, &c.]

"There are two kinds of crucibles, *viz.*, open and covered (lit. blind) * * * the covered one

(1) R. R. S. has borrowed the descriptions of Garbha Yantra*m* and Ha*m*sapāka Yantra*m*.

resembles the nipple of a cow and is fitted with a lid, which has a raised head.

"For the purification of silver, the crucible is best made of two parts of the ashes of *schrebera swietenoides*, and one part each of brick dust and earth."[1]

COLOUR OF FLAMES

"Copper yields a blue flame.........that of the tin is pigeon-coloured; that of the lead is pale-tinted[2]......that of the iron is tawny; ...that of the "peacock" ore (*s*asyaka) is red."[3]

TEST OF A PURE METAL

"A pure metal is that which, when melted in a crucible, does not give off sparks nor bubbles, nor spurts, nor emits any sound, nor shows any lines on the surface, but is tranquil like a gem.[4]

(1) The porous crucible is of the nature of a "cupel".

(2) Cf. "Lead compounds impart a pale tint to the non-luminous gas flame." (Roscoe and Schorlemmer.)

(3) The reading in the Mss. seems to be defective.

(4) Or in modern phraseology shows "signs of tranquil fusion.'

Koshṭī Apparatus

"For extracting the essence of metals a koshṭī apparatus [*Vide* Illustrations] is preferred, which is 16 digits in width and 2 cubits in length."

Colophon to Chapter IV.

"Here ends Chapter fourth of Rasārṇava, which treats of apparatus, crucibles and the colour of flames."

The Alkalies

"The three alkalies are the borax, troṇa (natron) and Yavakshāra (carbonate of potash). The ashes of sesamum, *achyranthes aspera, musa sapientum., butea frondosa, moringa pterygosperma, mochika, (schrebera swietenioides), raphanus sativus, zingiber officinale, tamarindus indicus* and *ficus relig.*, respectively are regarded as the standard plant ashes (क्षारगणः)। VII. 12-13

The Maharasas

"Bhairava said :—"mākshika, vimala, śilā, chapala, rasaka, sasyaka, darada (p. 78) and sroton-

jana,—these are the eight mahārasas." [*Vide* p. 79 and "Explanatory Notes on Minerals."] VII. 2-3

COPPER FROM THE PYRITIES.

"Mākshika, repeatedly soaked in honey, oil of *ricinus communis*, urine of the cow, clarified butter and the extract of the bulbous root of *musa sapientum*, and heated in a crucible, yields an essence in the shape of copper." VII. 12-13

"Vimala, digested with alum, green vitriol, borax and the watery liquid expressed from *moringa pter.*, *musa s.*, and finally roasted in a covered crucible in combination with the ashes of *schrebera swiet*, yields an essence in the shape of *chandrārka*[1] (lit. copper of gold-like lustre.)"

Chapala: [See under R. R. S. Bk. ii.] VII. 20-21

BRASS FROM CALAMINE AND COPPER MISTAKEN FOR GOLD.

"Rasaka: There are three, kinds of it; namely of yellow colour, of the appearance of treacle, and

(1) R. R. S. has borrowed this description and added some more characteristics of the mineral, from which it would appear that "Vimala" is also a variety of pyrites. [*Vide* R. R. S. Bk. ii.]

of the colour of stones. What wonder is it that Rasaka mixed with [certain organic matters] and roasted three times with copper converts the latter into gold?" VII. 31-34

EXTRACTION OF ZINC FROM CALAMINE.

Rasaka, mixed with wool, lac, *T. chebula* and borax and roasted in a covered crucible, yields an essence of the appearance of tin: of this there is no doubt." VII. 37-38

*S*asyaka. VII. 41-44

[These couplets have been borrowed word for word by R. R. S. *Vide* Bk. ii; hence repetition is unnecessary.]

SAURĀSHTRI.

Saurāshtri, alum, distillation of: (See under R. R̄. S., which has also borrowed this description *verbatim*.) VII. 73-74

THE METALS.

"O goddess! listen now to what I say about the metals.

'Gold, silver, copper, iron, tin and lead' these are the six metals and their resistance to waste [*i. e.* rusting] is in the order in which they have been mentioned." VII. 89-90

THE KILLING OF METALS—"VIDA."

"Hear attentively as I shall now speak of the killing of metals.

"There is no such elephant of a metal which cannot be killed by the lion of a sulphur." VII. 138-148

Bhairava said: "Kāsisa[1], rock-salt, the pyrites, sauvira[2], the aggregate of the three spices[3], sulphur, saltpetre, the juice expressed from mālati[4]—all these moistened with the juice of the root of *moringa pter.*, makes a vi*d*a, which would kill all [the metals]." IX. 2-3

"Sulphur, orpiment, sea-salt, salt, sal-ammoniac, borax—these digested with the ashes and the urines, give rise to another kind of vi*d*a." * * * * * * Having thus collected the ingredients, O goddess! begin the chemical operations. I have told you all, what more do you want to hear?" IX. 4-20

(1) Green vitriol. (2) Stibnite. (3) namely, black pepper, long pepper and dry ginger. (4) *Echites caryophyllata*, Rox.

PURIFICATION OF QUICKSILVER.

"Quicksilver rubbed with the juice of the aforesaid plants (*vide* original text) and distilled seven times, becomes pure."

"Quicksilver, made into a paste by being rubbed with copper and subjected to distillation, leaves behind tin and lead [with which they are often adulterated] and becomes pure." X. 55-56

KILLING OF MERCURY.

"Green-vitriol, alum, salt, borax, mixed with the aforesaid vegetable drugs, (*vide* original text), kill mercury in an instant [in the shape of calomel."] XI. 24

KILLING OF GOLD

"Salt-petre, green vitriol, sea-salt, rock-salt mustard, borax, salammoniac, camphor, the pyrites —all these are to be taken in equal parts. The crucible is to be smeared with the milky juice of *euphorbia neriifolia* and *asclepias gigantea*; then, having added the powder of the aforesaid "vi*d*a," the gold is to be killed, my beloved!"

XI. 83-84

Tests for Killed Mercury

"When the mercury assumes divers colours after having given up its fluidity, it is known as swooned; killed mercury is that which does not show signs of fluidity, mobility and lustre."

XI. 197-198

Colouring of Metals

"Iron, lead, and copper are coloured by means of calamine—the whole turns into gold." (Cf. VII. 31-34.) XII. 50

"Mercury is composed of the five elements and represents *S*iva himself." II. 78

"Take one pala of the ash of mercury and rub it with the same weight of sulphur and roast the mixture in a covered crucible: thus we get vermilion of the colour of the rising sun." XVI. 81

"Take the vitriol which is of the colour of the throat of the peacock, saffron, calamine, as also the excrement of a young calf, the poisons, powdered *plumbago zeylanica*, all in equal proportions, rub them with the acids and dry in the shade. Having added honey to the above mixture,

smear it on a thin sheet of lead. When roasted in a covered crucible, the lead is coloured in no time; the lead which is now of beautiful colour is fit for bedecking the persons of the gods."[1] XVIII. 70-74

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(1) Refers probably to the "gold-like alloy used by watch-makers" into the composition o which copper, zinc and lead enter. See Roscoe and Schor., II. p. 494, ed. 1897.

The Iatro-Chemical Period

(From 1300 A. D. to circa 1550 A. D.)

CHAPTER I

Chemistry in Rasaratnasamuchchaya

BOOK I

Salutation to him—the excellent, the greatest physician of the world by the nectareous ocean of whose benign glance, resplendent with brilliance, born of everything that is joyous and auspicious and which acts like unfailing elixir, the diseases of his devotees, such as birth, death, old age and worldly attachment, are cured in an instant.[1] 1

(1) The salutation is strictly Buddhistic and is on all fours with the opening lines of Vágbhaṭa's Ashtángarhridaya and of Amarakosha, both of which are known to be by Buddhist authors; cf. also Lalitavistara:

वैद्यः सर्वस्य लोकस्य वन्देऽहमपि त्वां विभो । VII. p. 123. R. L. Mitra's ed

जराव्याधिचिकित्सानां प्रादुर्भूतो भिषग्वरः । xii, p. 150.

Ādima,[1] Chandrasena, Lankesa, Bisārada, Kapāli, Matta, Māndavya, Bhāskara, Sūrasenaka, Ratnakosa, Sambhu, Sāttvika, Naravāhana, Indrada. Gomukha, Kambali, Vya*d*i, Nāgārjuna, Surānanda, Nāgabodhi, Yasodhana, Khanda, Kāpālika, Brahmā, Govinda, Lampaka and Hari—these are the twenty seven experts on Alchemy as also Rasā*m*kusa, Bhairava, Nandī, Svachchhanda-bhairava, Manthānabhairava, Kākachandīsvara, Vāsudeva, *Ri*shyasringa, the compiler of alchemy, the ascetic Rasendratilaka, Bhāluki, who has got the appellation of Maithili, Mahādeva, Narendra, Ratnākara and Harīsvara. 2-7

This treatise on well-tried mercurials and minerals, named "Rasaratnasamuchchaya," adapted to the treatment of diseases, is being compiled by the son of Si*m*hagupta, after having consulted the works of the aforesaid adepts and others. It will treat of mercury, the minerals and the metals, the construction of the apparatus, the mystical formulæ for the purification of the metals, the extraction of the essences (active principles), liquefaction and incineration. 8-10

[Here follows a description of the virtues of mercury and its mythical origin.]

(1) The Benares Ms. reads *Agama*.

By partaking of mercury, men are freed from a multitude of diseases, arising out of the sins of former existence—of this there is no doubt. 26

He who falls foul of mercury, which is the generative principle of *S*iva, will rot in the hell *æon* after *æon*. 29

From the mouth of the God of fire * * mercury dropped into the country of Darada[1] and it has there remained ever so long. The soil of that region, on being subjected to distillation, yields mercury. 89-90

COLOPHON

Here ends Book first of Rasaratnasamuchchaya, composed by Vāgbha*t*a, son of Si*m*hagupta, Prince of Physicians.

(1) Dardistan,the mountainous region about Kámír, is famous for the ores of cinnabar from which mercury is extracted. Darada is in fact a name of cinnabar. The auriferous region of the Daradas is mentioned by Humboldt (Kosmos 11. p. 513 E. C. Otte) who places it either in the Thibetan highlands east of the Bolor chain, west of Iskardo, or towards the desert of Gobi described also as auriferous by Hiouen Thsang. Regarding Párada and Darada see also Lassen's Alterthumskunde, 1. pp. 848-49. It seems probable that "párada" (quicksilver) and "darada" (cinnabar) owe their names to the countries from which their supply was obtained.

BOOK II

THE RASAS.

[In the Hindu Materia Medica the mineral kingdom is broadly divided into the Rasas and the Uparasas, the Ratnas (gems) and the Lohas (metals). The term Rasa is in general reserved for mercury, though it is equally applicable to a mineral or a metallic salt. In the oldest medical works, *e. g.* the Charaka and the Sus*r*uta, Rasa has the literal meaning of juice or fluid of the body, which according to the notions of humoral pathology engenders blood, serum, sweat, &c., (see p. 42). Rasakriyâ[1] in the Sus*r*uta means fluid extract or concentrated decoction. As mercurial and metallic preparations gradually came into vogue and even began to supplant the vegetable drugs, the term *rasa* began to be substituted for quicksilver on account of its semi-fluid character and its supposed miraculous therapeutical action on the juices or humours of the body (Cf. *Rig*-Veda, "Somarasa": *Vide* Intro.) In the Bâvaprakâsa we

(1) शालसारादिसारेषु पटोलत्रिफलासु च

रसक्रिया विधातव्या शोधनी शोधनेषु च। Sûtra Chap. xxxvi, 19.

find rasa used in a two-fold sense,—ancient and comparatively modern.[1]

In the older works Rasāyana (derived from *rasa*, juice, and *ayana*, way) means a medicine preventing old age and prolonging life—the *Elixir vitæ*.[3] Later on Rasāyana was almost exclusively applied to the employment of mercury and other metals in medicine and at present it means also alchemy (chemistry). Our author uses the term

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(1) सम्यक् पक्वस्य भुक्तस्य सारो निगदितो रसः ।
स तु द्रवः सितः शीतः स्वादुः स्निग्धश्चलो भवेत् ॥ Vol. I, p. 59. ed. Kālisa Chandra Sen Gupta.

In the above *sloka*, rasa is used in the sense of *chyle*. Again :—

रसायनार्थिभिर्लोकैः पारदो रस्यते यतः ।
ततो रस इति प्रोक्तः स च धातुरपि स्मृतः ॥ ibid. p. 442.

Here "rasa" is used as a synonym of mercury and regarded *as a metal*.

(3) For the definition of the term Rasáyana in the Charaka, see p. 32; cf. also "रसायनञ्च तज्ज्ञेयं यज्जराव्याधिविनाशनम्" *Sarngadhara*. Cf. also: "Dies Wort *(rasa)* nämlich hat nicht nur der *rasagnána*, d. i. Kenntniss der Säfte, einem Kapitel der Medicin, sondern einer Benennung der Alchemie, rasasástra, dann rasasiddhi, durch Quecksilber erlangte Vollkommenheit, das Vertrautsein mit der Alchemie, sowie desgl. rasendradarsana (wortl. Untersuchung des Säfte-Herrschers d. i. Quecksilbers), Lehre der Alchemisten (dieser heisst *Rasáyana*) seinen Namen geliehen und ausserdam in Compositen einer Menge chemischer Substanzen."—Pott: "Chemie order Chymie?" "Zeit. deut. Morg. Ges." xxx. 7

"Rasasiddhipradāyaka" (1-5), which is derivied from rasa, mercury, siddhi, accomplishment and pradāyaka, giver or bestower, *i.e.* lit. giver of accomplishment in mercury *i.e.* an expert on alchemy. Wilson in his Dictionary thus happily renders Rasasiddhi: "The knowledge of alchemy, the possession of peculiar familiarity with mercury obtained by the performance of chemical operations conjoined with certain mystical and magical rites and the securing thence to the adept of happiness, health and wealth; the power of transmuting metals and the art of prolonging life."

With these prefatory remarks, we shall now allow our author to proceed.]

Abhra (mica), Vaikrānta, Mākshika (pyrites), Vimala, Adrija (bitumen), Sasyaka, Chapala, and Rasaka: these 8 rasas are to be identified and collected.[1] [*Vide* "Explanatory Notes on the Minerals" at the end of Chap. I][1] 1

Abhra

There are three varieties of mica, namely,

(1) Rasárnava (p. 69) recognises the following eight minerals:—mákshika, vimala, adrija, chapala, rasaka, darada (cinnabar) and srotonjana (stibium).

pinâka*m*, nâgamandûka*m* and vajra*m* and each of these again are of four different colours—white, red, yellow and black. 5-10

Mica, the layers of which can be easily detached, is preferred. Mica, which is as bright as the moon and which has the lustre of the rust of iron, does not take up or combine with (lit. swallow) mercury. That which has taken up mercury can alone be used with the metals and administered in medicine. Mica, which has been *killed*, is prescribed in the treatment of various diseases. The variety which has the lustre of the moon, if taken internally, brings on dyspepsia and urinary disorders. 12-14

Mica, heated seven times and plunged into sour gruel or cow's urine or decoction of the chebulic myrobalans or cow's milk, is freed from all impurities. 17-18

Mica, mixed with paddy grains and reduced to powder, tied in a piece of cloth and suspended in sour gruel and then passed through linen, is known as Dhânyabhra*m* (lit. mica in combination with paddy). Dhânyabhra*m*, rubbed with the juice of *cassia sophora* and roasted ten times in a closed crucible, is *killed* thereby. 24

Vaikranta

Vaikrānta has eight faces and six angles, is slippery and heavy and of uniform or mixed tint. It has 8 different colours, *viz.*, white, red, yellow blue, with the shades met with in the down of the pigeon, grass-green, black and variegated 55-56

Vaikrānta is a powerful tonic and reckoned among the sovereign medicines. It is a destroyer of all (bodily) disorders and is employed in the place of diamond. 57-58

Vaikrānta is purified by being heated three days with the salts and the alkalies or by digestion with the acids, urines or a decoction of *dolichos uniflorus* and the plantain or of *paspalum scrobiculatum.* It is killed by being roasted in a covered crucible eight times in combination with sulphur and lemon juice and *pasp. scrobi.* 67-68

Vaikrānta, after being heated and plunged into the urine of the horse, ought to be repeatedly roasted and then reduced to ashes. 69

Vaikrānta after incineration is substituted for diamond. 70

Macerated in the ashes of *schrebera swiet. butea frondosa* and cow's urine and mixed with the powdered root of *euphorb. antiq.*, turmeric . . .

borax, powdered lac and made into balls with the milky juice of *asclepias gem.*, and honey and strongly heated in a closed crucible, vaikrānta yields its essence. Of this there is no doubt.

71-72

COPPER PYRITES

Mākshikam (pyrities) is born of mountains yielding gold . . and is produced in the bed of the river Tāpī and in the lands of the Kirātās, the Chinese and the Yavanas. 77

Pyrites is of two kinds—golden and silvery: the former is a native of Kanouj and is of golden yellow colour. The silvery pyrites is associated with stones and is of inferior quality. 81

Rubbed with the juice of lemons and sulphur and roasted in a closed crucible it is *killed*. 84

Mākshika, repeatedly steeped in honey, oil of the seeds of *ricinus communis*, urine of the cow, clarified butter and the extract of the bulbous root of *musa sapientum* and gently roasted in a crucible, yields an essence in the shape of copper. 89-90

VIMALA

Vimala is described as of three kinds according as it has the lustre of gold, silver and brass respectively.

96

It is rounded and is also endowed with angles and faces. 97

It is killed by being roasted ten times with sulphur, bitumen, *artocarpus lakoocha* and the acids. 100

Vimala, rubbed with borax, the juice of *artocarpus lakoocha* and the ash of *schrebera swiet.*, and roasted in a covered crucible, yields an essence of the appearance of gold.[1] 101

Vimala digested with alum, green vitriol, borax and the watery liquid expressed from *moringa pter.*, *musâ s.* and finally roasted in a covered crucible in combination with the ashes of *schrebera swiet.*, yields an essence in the shape of chandrârka (lit. copper of gold-like lustre). 103-104

*S*ILAJATU

*S*ilajatu (bitumen) is of two kinds, one having the smell of cow's urine, the other resembling camphor. It oozes out in the heat of the sun at the foot of the Himâlayas from the bowels of gold, silver and copper respectively.[2] (cf. *ante* p. 46) 106

(1) The text reads : ; सीसकाभम : —*lead-like*, which however conveys no adequate meaning. A variant is सौवर्णाभम :—*gold-like*.

(2) The resins of the styrax benzoicum and also a variety of bitumen, especially the latter are referred to. The description is evidently borrowed from the Charaka and the Susruta.

SASYAKA

Sasyaka (blue vitriol) . . . has the play of colour in the throat of the peacock (*i.e.* has blue tint). Mayuratuttham is an emetic, an antidote to poisons and a destroyer of the whiteness of the skin. 127-129

It is killed by being roasted in a covered crucible with the juice of *artocarpus lakoocha*, sulphur, bitumen and borax, 132

EXTRACTION OF COPPER

Take blue vitriol and one-fourth its weight of borax and soak the mixture in the oil expressed from the seeds of *pongamia glabra* for one day only and then place it in a covered crucible and heat in the charcoal fire—by this process an essence is obtained from it of the beautiful appearance of coccinella insect.[1] 133-134

Or, enclosed in a crucible with borax and the juice of lemons and strongly heated, it yields an essence in the shape of copper. 135

Pure blue vitriol, of the colour of peacock, in

(1) *i. e.* red ; in the Charka, blood is described as having the colour of the *coccinella* insect. Couplets 133 and 134 have been borrowed almost *verbatim* from Rasárnava.

combination with the aforesaid drugs and by the application of various processes, gives up its essence. 136

Chapala

There are four varieties of Chapala—yellow, white, red and black. That which has the lustre of gold or silver is most appropriate for the fixation of mercury. The last two are indifferent and readily melt like lac and are useless. Chapala melts like tin when heated over fire—hence the name. 143-144

Chapala has six faces and the lustre of a crystal.[1] 146

Rasaka

Rasaka(calamine) is of two kinds : the one of laminated structure is known as dardura ; the other, non-laminated, is called karavellaka. 149

Calamine is to be heated and plunged seven times into the juice expressed from the seeds of lemon or immersed in the urine of man or of horse or in sour gruel or sour milk and thus purified. 154-155

(1) It is not clear what substance is really meant by the term Chapala ; its radical meaning is mobile or fickle, hence it is a name often given to quicksilver.

Extraction of Zinc

Rub calamine with turmeric, the chebulic myrobalans, resin, the salts, soot, borax and one fourth its weight of *semicarpus anacardium*, and the acid juices. Smear the inside of a tubulated crucible with the above mixture and dry it in the sun and close its mouth with another inverted over it, and apply heat. When the flame issuing from the molten calamine changes from blue to white, the crucible is caught hold of by means of a pair of tongs and its mouth held downwards and it is thrown on the ground, care being taken not to break its tubulure.[1] The essence possessing the lustre of tin which is dropped is collected for use.

157-161

Calamine is be powdered with lac, treacle, white mustard, the myrobalans, natron and borax and the mixture boiled with milk and clarified butter and made into balls. These are to be enclosed in a crucible and strongly heated. The contents are then poured on a slab of stone—the essence of calamine of the beautiful appearance of tin (thus obtained) is to be used. 163-164

(1) The Benares Ms. reads "यथा नाल भज्यते" and drops न which would mean so "as to break its tubulure."

Or a vessel filled with water is to be placed inside a kosh*th*ī apparatus and a perforated cup or saucer placed over it; a crucible charged as above is to be fixed in an inverted position over the saucer and strongly heated by means of the fire of jujube *(zizyphus jujuba)* charcoal: the essence which drops into the water should be applied (in medicine). [*vide* illustrations] 165-166

This essence is to be mixed with orpiment and thrown over an earthen dish and rubbed with an iron rod till it is reduced to ashes. [From the context it is evident that the operation is to be performed over fire.] 167-168

BOOK III.

THE UPARASAS OR INFERIOR RASAS

Sulphur, red ochre, vitriol, alum, orpiment, realgar, anjana and ka*m*kush*th*a—these are the eight uparasas, useful in operations of mercury. 1

[Here follows the mythical origin of sulphur.]

* * * *

SULPHUR

Sulphur is of three kinds: that of the first quality resembles the beak of a parrot; that of the second quality is yellow; whereas the white variety is the worst. Another authority says: there are four kinds of sulphur according as it is of white, yellow, red and black colour respectively......the black variety is rare.[1] 12-15

Melted sulphur is poured into the juice of *verbesina calendulacea* and thus purified.

A vessel which contains milk has its mouth tied down with a piece of cloth, over which is deposited finely powdered sulphur; the latter again covered with an earthen bowl. Heat is applied from above by burning cow-dung cakes. The melted sulphur drops into the milk and is thus purified. 24-25

GAIRIKA

Gairika (red ochre) is of two kinds: the one, pāshāṇa gairika, is hard and copper-coloured; the other is svarṇa gairika *i. e.* of the colour of gold (yellow). 46

(1) Cf..."il y a des soufres des diverses couleurs; l'un rouge, l'autre jaune un autre blanc pariel á l'ivoire;...un autre, noir, qui ne vaut rien." "La Chimie au moyen âge," 1, 307.

Kaśisa

Kāśisa (sulphate of iron) is of two kinds: vālukā-kāśisa and pushpa-kāśisa. [The former termed in other works dhātukāsīsa is the green variety and the latter, the *basic* or yellowish variety.] 51

Its essence is to be extracted like that of alum. 54

Tuvari

Tuvarī (alum): the fragrant earth produced in the mountains of Surat is known as tuvarī, which dyes cloth and fixes the colour of madder.[1] 59

A second variety of it called phatakī or phullikā is slightly yellow . . . Another variety known as phulla tuvarī is white and acid in taste; iron changes to copper by the process of *lepa* [cf. Bk. VIII, 80, where the term "रूप:" is used in the sense of transmutation of the baser metals. The author seems to convey the idea that alum plays an important part in this process.] 60-62

Alum is astringent, acid, beneficial to the eye . . and *killer* of mercury.[2]

(1) *i.e.* forms lakes.

(2) पारदमारणी ; Cf. the various formulæ for the preparation of calomel in which alum yields sulphuric acid and plays an important part.

Alum is to be macerated in the bile of the ox one-hundred times and then its essence is to be extracted by distillation[1]—a very secret process, not to be divulged. 65

TALAKA

Tālaka (orpiment) is of two kinds: the one is of a leafy structure, the other is found in balls or cakes and is of golden colour . . . and bright. 66

It is purified by being digested in the juice of cucumber and the alkaline water of the ashes of sesamum or in lime water. 69

Tālaka is to be rubbed with buffalo's urine and thrice macerated in the decoction of *butea frondosa* of the consistency of honey, and then to be roasted in a covered crucible and powdered. This operation is to be repeated twelve times. It is then fit to be used in medicines.[2] 74-75

Take one pala of tālaka and rub it for one day with the milky juice of *calopropis gigantea* and mix

(1) पातयेत् सत्वम् ; here distillation is expressly mentioned. Couplet 65 is borrowed from Rasárnava.

(2) Most likely a sulpharsenite of potash is formed. The process in Rasendrasárasamgraha is more scientific. "Tālaka is to be cut into small pieces and rubbed with lime water and the alkaline water derived from the ash of *achyranthes aspera* and is then to be enclosed in carbonate of potash and roasted."

it with the same weight of oil and heat it in an open place for 7 days and nights together. Collect the white essence when it has cooled down.[1] 80-81

MANASSILA

Manassila (realgar) is mixed with one-eighth part of its weight of iron-rust, molasses, bdellium and clarified butter and enclosed in the koshṭī apparatus [see p. 69] and strongly heated, when it yields its essence. 95

THE ANJANAS

The Anjanas (collyriums): of these there are Sauvīrānjana, Rasānjana, Srotonjana, Pushpānjana, and Nīlānjana; their properties are described below. 97-98

Nīlānjana is a *killer* of gold [cf. the *killing* of gold, silver, iron and copper in Vāgbhaṭa, p. 55] and induces softness in iron, *i.e.* renders it easily pulverizable [as the iron becomes impregnated with the brittle sulphide of iron; cf also Bk. viii, 38.] 104

The essence of the anjanas is to be extracted like that of realgar.

(1) It is evident that the operation is to be performed in a glass retort or in the koshṭī apparatus described below under realgar.

[We quote below the account given in Dutt's "Materia Medica of the Hindus" as our author gives rather scanty information on this point:

"Galena or sulphide of lead is called anjana or sauvīrānjana in Sanskrit, and krishna surma in vernacular. It is called anjana which literally means collyrium or medicine for the eyes, from the circumstance of its being considered the best application or cosmetic for them. The other varieties of anjana mentioned are Srotonjāna, Pushpānjana and Rāsānjana.

"Sauvīrānjana (सौवीराञ्जन) is said to be obtained from the mountains of Sauvira, a country along the Indus, whence it derives its name. The article supplied under its vernacular name surma is the sulphide of lead ore. Sauvira is usually translated as sulphide of antimony, but I have not been able to obtain a single specimen of the antimonial ore from the shops of Calcutta and of some other towns. The sulphide of antimony occurs in fine, streaky, fibrous, crystalline, masses of a radiated texture: The lead ore on the contrary occurs in cubic masses destitute of rays and is tabular in its crystalline arrangement.

"Srotonjana (स्रोतोञ्जन) is described as of white colour, and is said to be produced in the bed

of the Yamunā and other rivers. It is called Saffed Surma in the vernacular, and the article supplied under this name by Hindustani medicine-vendors is calcareous Iceland spar.[1] It is used as a collyrium for the eyes, but is considered inferier to the black surma or galena.

"Pushpānjana (पुष्पाञ्जन is described as an alkaline substance. I have not met with any vernacular translation of this word nor with any person who could identify or supply the drug. Wilson, in his Sanskrit-English Dictionary, translates the term as calx of brass, but I know not on what authority.

"Rasânjana रसाञ्जन is the extract of the wood of *berberis Asiatica* called *rasot* in the vernacular."]

Kā*m*kush*tham* is produced at the foot of the Himalayas . . . Some are of opinion that it is the excrement of a new-born elephant . . . it is of white and yellow colour and is a strong purgative.[2] 109-112

(1) See, however, *ante* p. 55.

(2) Not well made out. According to Wilson, it is a medicinal earth, described as of two colours, one of a silvery and the other of a gold colour.

THE COMMON RASAS

Kampilla, Chapala[1] Gauripāsh*āṇ*a, Navasāraka, Kaparda, Agnijāra, Hingula, Girisindūra, M*ri*ddārasringaka*m* : these are the eight common Rasas regarded as useful adjuncts to chemical operations by Nāgārjuna and other experts. 120-121

Kampilla[2] is like brick-dust . . . a purgative . . . natural product of Surat . . . and a vermifuge.

Gauripāshāna[3] is of the lustre of rock-crystal, conch and turmeric respectively . . . its white essence is to be extracted like that of orpiment. 124-125

NAVASARA AND OTHER RASAS

Navasāra (sal ammoniac) is begot of the decomposition of the shoots of bamboos and of the wood of *careya arborea* ; navasāra is an alkali, its another name is chulikālava*ṇ*a (lit. salt deposited in

(1) Including Chapala there are nine common Rasas ; but Chapala has already been considered as a mahārasa. (see p. 87)

(2) The red mealy powder covering the capsules of *mallotus Phillippensis*, also known as kamalā. It is not clear why this substance should have found a place among the products of the mineral kingdom.

(3) Not easy to identify ; lit., it means white stone or marble.

the hearth), it is produced during the burning of the brick . . . it kills mercury, liquefies iron, is a stomachic, an absorbent of the spleen, and aids digestion after much eating.[1] 127-129

Varātaka (cowrie or marine shell): alchemists prefer shells which are of yellow colour, knotty and possessed of circular lines on the dorsal side . . . macerated for three hours in sour gruel, it undergoes purifications.[2] 130-134

Agnijāra is a substance discharged from the

(1) It is of interest to note that Royle, who wrote in 1837, regrets that "no Hindu work on this subject (chemistry) has yet been translated," and is bold enough to predict that "Sal ammoniac must have been familiar to the Hindus, ever since they have burnt bricks, as they now do, with the manure of animals as some may usually be found crystallized at the unburnt extremity of the kiln."—"Antiquity of Hindu Medicine." Royle's surmises have proved to be literally correct. The word "Navasára" is apparently of Persian origin being corrupted from "*Nausadar.*"

(2) The text is almost exactly the same as in "Rasendrasára-sawgraha," which gives an additional method of purifying the cowrie, namely:—"Dig a hole in the ground and fill it partly with the husk of paddy, now place on it a crucible containing cowries; cover it with cow-dung cakes and set fire to the mass. By this process the cowries are reduced to ashes." It is the lime thus obtained, which is often used in medicine.

womb of a kind of sea-crocodile and dried in the sun.[1] 135

Girisindūra (lit. vermilion derived from the rocks) occurs among the big mountains (inside the rocks). 137

Hingula (cinnabar: Syn. darada, see p.78); quicksilver extracted from it is as efficacious as killed sulphur. When darada is placed in a retort and its essence collected in water, it yields the same substance as quicksilver—of this there is no doubt. (The apparatus referred to is shown in the illustrations). 141-144

M*ri*ddarasringaka*m* [various readings of the text are given; it is not easy to make out what substance is meant]. It is yellow and of leafy structure and occurs in Gujārat and round about mount Abu. 145

Rājāvarta (Lapis lazuli) has a bluish tint but with slight admixture of red ...... it is killed by being powdered in combination with lemon juice and sulphur and roasted 7 times in a covered crucible. 149-153

(1) Not identified. Perhaps the origin is mythical. नक्र is a crocodile, but as is well-known this Saurian never flourishes in the sea. According to राज निघण्टु agnijāra is a marine medicinal plant.

BOOK IV

THE GEMS

The gems also are regarded as the agencies, which help the fixation or coagulation of mercury. These are the gems: Vaikrānta, Suryakānta (sun-stone), Hīraka*m* (diamond), Mauktika*m* (pearls), Chandrakānta (moon-stone), Rājāvarta (lapis lazuli) and Garu*d*odgara, the emerald (lit. derived from the vomit of Garu*d*a); the topaz, the sapphire, the coral, the cat's eye are also reckoned among the gems. These are to be carefully collected for the fixation of mercury.[1]

(1) The ruby and the zircon are also mentioned. The Vaikrānta "is a kind of gem said to resemble a diamond, and to be of similar properties." Wilson. Suryakānta and Chandrakānta are gems of fabulous existence, supposed to be formed by the congelation of the rays of the sun and moon respectively. They may also refer to some sort of crystals. The description of the gems, other than diamond, is meagre and vague. The following extracts from Manimāla or "A Treatise on Gems" by Sir Raja Saurindra Mohan Tagore, Mus. Doc., will, to a certain extent, make up for the deficiencies.

"Mention is made of gems and jewels in the earliest writings of the Hindus. The Vedas speak of a place illuminated by rubies and diamonds, which gave out a light as refulgent as that of the planets. Precious stones play a prominent part in the mythologies

VAJRA*M*

Vajra*m* (diamond) is of three kinds: male, female and hermaphrodite, and its medicinal properties vary in excellence in the order in which they have been spoken. 26

The one with 8 angles and 8 faces and 6 corners, very brilliant, with the play of rainbow-colours[1] is known as the male diamond, whereas the female diamond is flattened and rounded whilst the neuter is rounded, obtuse-angled and slightly heavy. 27-28

Each of these again is divided into 4 classes according to its colour namely: Brāhma*n*a, Kshatriya, Vai*s*ya and *S*ūdra.[2] 30

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of the Hindus, in their traditions, poems and legends. In the two great epics of Hindustan, the Rámáya*n*a and the Mahábhárata, frequent mention is made of stones and pearls with which the kings and the people of the period used to decorate their person."

(1) The high refractive and dispersive power of diamond is evidently referred to.

(2) "Diamonds white like the conch, waterlily, or crystal are Brāhma*n*as; those which are red like the eyes of the hare are Kshatriyas; those which are verdant like the cool plantain-leaf are Vai*s*yas; those which resemble in colour the clean sword, are known as *S*udras." Manimála, 1.100.

Diamond is a bestower of long life, a tonic, an allayer of the three derangements [namely, of air phlegm and bile], a killer of all the ailments, a fixer of mercury, a subduer of death—in short it is like nectar.

Diamond is digested in the decoction of kulattha (*dolichos uniflorus*) or of kodrava (*paspulum scrobiculatum*) for three hours and thus purified. Diamond is to be macerated four times in the blood of the bug and enclosed in a ball made of the flesh of the musk-rat and then to be roasted in a covered crucible 30 times or to be heated 100 times and plunged in the decoction of kulattha. 34-37

Diamond is to be placed in a covered crucible, the inside of which has been coated with realgar, rubbed with the decoction of kulattha and the juice of *artocarpus lakoocha* and roasted 8 times in succession in the fire of dry cow-dung cakes. It is then heated 100 times and thrown into pure mercury—the diamond is thus killed and reduced to fine ashes. 38-39

The veracious alchemist Somasenānī,after having convinced himself of the success of this process by his own experiments, has given it to the world. 40

Diamond is to be 7 times smeared in the blood

of the bug and dried in the sun and then to be placed in an iron pot and filled with the juice of *cassia sophora* and heated 7 times. The diamond is sure to be reduced to ashes. This process has been described by the sage Brahmajyoti. 41-42

Diamond smeared with the powder of lead, levigated in the juice of the fruit of madana (*randia dumetorum*), and roasted 20 times in a covered crucible, is reduced to fine powder, which is to be used in medicines.[1]

General Process of Reducing Gems to Ashes

All the gems with the exception of diamond are killed when roasted eight times with a mixture of realgar, sulphur and orpiment, rubbed in the juice of *artocarpus lakoocha*. 63

Take asafœtida, the five salts, the three alkalies, *rumex vesicarius*, sal ammoniac, the ripe fruit of the croton plant, jālāmukhi (*anthericum tuberosum*), rudanti (*asclepias rosea*), the root of *plumbago zeylanica*, and the milky juice of *euphorbia antiquorum* and *calotropis gigantea*—rub all

(1) One or two processes not mentioned by our author may be quoted from "Rasendrachintāmanis":—

these together and make them into a ball. Place inside it the noble and luck-yielding gems. Wrap the ball with the leaves of betula bhojpattra and tie them with thread and enclose the ball again in a piece of cloth and suspend it in a dolāyantra (see Bk. IX) filled with the acids and sour gruel and apply strong heat for three days and nights—the liquid principle of the gems is thus collected.

64-69

Powdered pearl is to be rubbed with the juice of *rumex vesicarius* and then transferred inside a lemon and stowed in a mass of paddy. At the end of a week it is heated in a crucible and liquefied.[1]

70-71

"Take the root of *piper betle* or of the cotton plant *(Gossypium herbaceum)* three years old, and rub it into a paste and enclose the diamond in it and roast it in a covered crucible seven times, when the diamond will be killed."

"An intelligent person should place in a brass vessel a frog which out of fright will pass water. A diamond is to be heated and plunged into this urine. This process being repeated several times, the diamond is killed." This last recipe is also to be found in Sarngadhara. Couplets (44-45) do not occur in the Benares Ms.

(1) Couplets 70, 71 and 72 do not occur in the Benares Ms

Diamond, placed inside the stem of *vitis quadrangularis*[1] and heated four weeks in acids, is liquefied. 72

Vaikrānta, which is of white colour, liquefies when macerated in the juice of *rumex vesicarius* and exposed to the sun for a week. 73

Take the juice of *pandanus odoratissimus* rock-salt, svarna pushpikā together with *coccinella* insect. Vaikrānta melts on being digested in this concoction for a week. 74

BOOK V

On Metals[2] (लोहानि)

The pure metals are: gold, silver, and iron. The putilohas (lit. metals emitting a fœtid odour) are two: lead and tin. Dhātuloha*m* is iron proper and often conveys different meanings. The alloys are three in number: brass, bell-metal and vartaloha. 1

(1) वज्रवल्ली according to "Vaidyakasabdasindhu" is the same as अस्थिसंहारलता *i.e. vitis quadrangularis.*

(2) Loha (lit. iron) is often used in the wider sense of a metal.

GOLD

Gold is known to be of five kinds:—of which 3 are attributed to mythical and celestial origin; the fourth is called kshaṇija (lit. begot of mines): the 5th is obtained by the transmutation of the baser metals. (See Bk. VIII, 80-83.) 2

Gold is to be purified and killed, as otherwise [if taken internally] it robs one of strength, virility and happiness and brings a series of maladies. 11

Gold-leaf of the weight of one *karsha* is to be smeared with salt and placed between two earthen saucers and heated on a charcoal fire for an hour and a half when its true colours will come out. 12

The best method of *killing* all the metals is with the aid of the ashes of mercury.[1] The next best is through the agency of the roots, whereas *killing* with sulphur is least to be recommended. 13

When a metal is *killed* with ariloha (meaning: not clear), it is injurious. Gold-leaves, pierced with holes and coated with a paste of lemon juice and the ashes of mercury and roasted ten times are thereby *killed*. 14

Project into melted gold its own weight of the ash of marcury; [when cooled] powder it and rub

(1) Generally sulphide of mercury (see p. 65).

it with lemon-juice and cinnabar and roast it in a covered crucible twelve times. The gold thus acquires the colour of saffron.[1] (cf. Rasârnava XVI. 81, p. 74). 15-16

Gold-leaf is killed by being rubbed with one-fourth of its own weight of *killed* mercury and acid of any kind and roasted eight times.[2] 17

SILVER

Silver is of 3 kinds : namely sahaja*m* (of mythical origin), begotten of mines and artificial. 22

Silver melted with lead and borax undergoes purification ...... Arrange on an earthen dish a mixture of lime and ashes in a circular row and place in it silver with its equal weight of lead. Now roast it over fire until the lead is consumed. Silver thus purified is to be used for medicinal purposes.)[3] (Cf. p. 68) 32-34

(1) This refers to the mistaken notion that the sublimate of factitious cinnabar (vermilion) contains gold.

(2) It will be seen that although *killing* with sulphur direct is not recommended, the gold is in reality converted into the sulphide and afterwards into metallic gold in a fine state of powder. See under "Killing of Metals."

(3) Cf. Rasârnava [illegible] शुद्धिमृच्छति "Silver is purified by being melted with lead and the ashes." The process is practically that of cupellation.

Silver-leaf is to be rubbed with mercury and the juice of *artocapus lakoocha* and is to be embedded in sulphur and heated in a covered crucible over a sand-bath; when cold, the mass is once more rubbed with orpiment and acids and roasted 12 times. By this process, the silver is reduced to ashes 35-37

Silver is reduced to ashes by being 3 times rubbed with powdered iron pyrites and lemon juice and roasted in a covered crucible. 38

Take 4 parts of silver-leaf and one of orpiment and rub them with the juice of lemon and roast the mixture and repeat the operation 14 times and thus silver is completely incinerated.[1] 40-41

COPPER

There are two varieties of copper: the one brought from Nepal is of superior quality; that dug out of the mines of other countries is designated Mlechchha.[2] 44

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(1) We shall complete the account with an extract from Rasendrasárasamgraha: "Siver-leaf is pierced with holes and smeared with twice its weight of cinnabar and subjected to distillation in the Pátana Yantra (see Bk. IX on apparatus). The mercury comes off and *killed* silver remains behind."

(2) The generic term for a barbarian or a foreigner.

Copper-leaf is killed by being rubbed with lemon-juice, sulphur and mercury and roasted thrice 55

IRON

There are three kinds of iron: namely, mun*d*a*m* (wrought iron), tīksh*n*a*m* and kānta*m*; mun*d*a*m* again is of 3 varieties: *viz.*, m*ri*du, ku*nth*am and ka*d*āra*m*.

That which easily melts, does not break and is glossy is m*ri*du; that which expands with difficulty when struck with a hammer is known as ku*nth*a*m*; that which breaks when struck with a hammer and has a black fracture is ka*d*āra*m*. 71-72

Tīksh*n*a*m* (properly cast-iron, steel): there are 6 varieties of it. One variety is rough and free from hair-like lines and has a quicksilver-like fracture and breaks when bent. Another variety breaks with difficulty and presents a sharp edge.

75-78

Kānta*m*: there are 5 kinds of it, namely, bhrāmaka, chumbaka, karshaka, drāvaka and romākānta. It possesses one, two, three, four and five faces and often many faces [with which to attract iron] and is of yellow, black and red colour respectively. The variety which makes all kinds of iron move about is called bhrāmaka, that which kisses

iron is called chumbaka, that which attracts iron is called karshaka, that which at once melts the iron is called drāvaka (lit. a solvent) and the fifth kind is that which, when broken, shoots forth hair-like filaments. 84-89

Mercury is like an intoxicated elephant and kāntam is like the bent hook wherewith to restrain it. The wise man digs it out of the mines. That which has remained exposed to the sun and the atmosphere is to be avoided.[1] 92-93

If water is kept in a vessel and oil poured over it and the oil does not spread about; if asafœtida gives up its odour and decoction of neem *(Melia azadirachta)* its bitterness and milk, being boiled in it, does not overflow but rises high like a peak—if such be the characteristics of the vessel, know that it is made of kånta iron. 94

Powdered iron is to be macerated awhile in the decoction of the three myrobalans, in cow's urine and then to be mixed up with clarified butter and fried in an earthen vessel and stirred with an iron rod until a blade of straw thrown over it catches fire. The iron powder is to be pounded and the above process repeated five times.

(1) Couplets 84-93 are taken bodily from Rasárnava.

Or iron is roasted four times in a covered crucible with the decoction of the myrobalans and is reduced to fine powder.[1] 104-105

Leaves of tīkshna iron are repeatedly to be heated and plunged into water and then to be powdered in a stone mortar with an iron pestle * * * The powder of iron thus obtained is to be roasted twenty times in a covered crucible in combination with mercury and sulphur, and after each roasting the powder of iron is to be pounded as directed above—iron thus reduced to ashes is to be used in medicine. 107-110

Take one part of iron and twentieth part of its weight of cinnabar and rub them with lemon juice and sour gruel and roast the mixture in a covered crucible. The operation being repeated 40 times, kāntam, tīkshnam and mundam are killed—of this there is no doubt. 113-114

Take of mercury one part, sulphur two parts and iron powder three parts and rub them with the juice of the Indian aloe and after 6 hours transfer the mass to a brass-vessel and cover it with the leaves of the castor-oil plant. At the end of an hour and a half the mass will become heated. It is

(1) The process is practically the same as that of Chakrapāni, who ascribes it to Nagárjuna. (See p. 62.)

then buried under a heap of paddy grains and taken out after three days and then powdered very fine and the contents passed through linen.[1] All the three varieties of iron are thus completely killed. Gold and other metals can be killed by this process after being reduced to fine powder like iron.

134-137

Rust of iron is to be heated and powdered till it is reduced to fine powder—this is called man*d*ûra.[2] 147

The qualities which reside in killed iron are also to be found in the rust of iron, hence the latter may be substituted for the treatment of diseases. [3]

148

TIN

Vanga*m* (tin) is of two kinds—kshuraka*m* and mis*r*aka*m*; the former is endowed with superior qualities; the latter cannot be recommended for medicinal uses. 153

(1) "Rasendras*r*rasa*m*graha" has the same recipe with slight variations. According to it the powder is so fine that it "floats on water like a duck." Cf. below p. 119.

(2) Analysis of "Mandûra"; see Appendix I.

(3) This couplet also occurs in Rasendras*r*rasa*m*graha.

Kshuraka*m* is white, soft, cool (to the touch), readily fusible and bright and does not clink (when struck). 154

Misraka*m* is dirty white * * * This is an anthelmintic and a destroyer of the urinary disorders. 155

Molten tin is dropped into the juice of *Negundo vitex* mixed with turmeric; the process being repeated 3 times, the metal undergoes purification.
154-156

Tinfoil is to be smeared with a paste of orpiment and the milky juice of *Calotropis gigantea* and then to be covered with the ashes of the bark of *Ficus religiosus* and *Tamarindus Indicus* and roasted and then reduced to ashes.[1]

LEAD

Sisaka*m* (lead) is readily fusible, very heavy,

(1) A few more recipes are given, in all of which orpiment plays an important part; the one quoted below from Rasendrasárasamgraha will yield the "ash" of tin in the shape of an oxide: "Melt tin in an earthen pot and to the molten metal add an equal weight of powdered turmeric and Ajowan (*Ptychotis ajowan*) and cumin seeds, and afterwords the ashes of the bark of *Tamarindus Indicus* and *Ficus religiosus* and continue stirring over fire. The tin will be reduced to ashes."

presents a black and bright appearance on fracture, is of fœtid odour[1] and black exterior. 171

Take of lead 20 palas and apply strong heat to it and drop into the molten metal one karsa of mercury and throw into it one after another the ashes of *Terminalia arjuna, T. bellerica,* pomegranate and *Achyranthes aspera,* weighing one pala each. The mass being vigorously stirred with an iron spoon for 20 nights in succession, the metal is calcined yielding a bright red ash.[2] 176-179

(1) Lead and brass (see below) are said to emit an offensive odour. In connection with this it is interesting to read Professor W. E. Ayrton's address "On the Smell of Metals"—Brit. Assoc. Rep. 1898, p. 772. Cf. also "Alch. Syr." *Trad.*, 121, as well as the opening lines of the present Book describing tin and lead "as metals of fœtid odour." In the Syrian Alchemy "Silver is distinguished from tin by its absence of fœtid odour"; regarding this M. Berthelot very pointedly remarks: "on voit que l'odeur propre que dégagent les mémaux frottés avec la main, ou bien au contact d'une matière organique, jouait un rôle important dans leur étude chez les anciens auteurs; importance que cette odeur a perdue aujourd'hui.—"La Chimie au moyen âge": T. ii. 121 (trad.)

(2) The following process is given both in the "Rasendrachintâmani" and "Rasendrasârsamgraha": "Rub lead with the juice of *Adhatoda vasica* and melt it in an earthen pot add to it one fourth its weight of the ashes of *Adhatoda* and *achyranthes aspera* and stir the mass with a rod *Adhatoda vasica* and heat over a fire. Repeat the process seven times. The lead will be turned to vermilion-like powder."

Leaves of lead are to be smeared with a paste of orpiment and the milky-juice of *Calotropis gigantea* and roasted in a covered crucible till the metal is entirely killed. 184

BRASS, BELL-METAL, &C.

Pittala (brass) is of 2 kinds—ritikā and kākatu*n*dī; the former on being heated and plunged into sour gruel turns copper-coloured. 192-193

Brass, which is heavy, soft, of yellow colour, capable of resisting strokes, is to be recommended. 195

Brass, which is light and of offensive odour, is not good for medicinal purposes. 196

Brass, smeared with a paste of lemon juice, orpiment and sulphur and roasted 8 times, is reduced to ashes. The process of killing brass is the same as that of copper. 201-202

Kā*m*sya (bell-metal) is made by melting together 8 parts of copper and 2 parts of tin. 205

It is completely killed by being roastad 5 times with sulphur and orpiment. 210

Vartaloha*m* is produced from Kā*m*sya, copper, pittala, iron and lead; hence it is regarded by metallurgists as an alloy of 5 metals................. It is killed with the aid of sulphur and orpiment. 212-216

BOOK VI

Initiation into Discipleship

[This chapter is full of directions for the mystic Tāntric rites after the performance of which the pupil is to be initiated into the secrets of mercurial lore.]

The instructor must be wise, experienced, well-versed in chemical processes, devoted to *S*iva and his consort Pārvatī sober and patient. The pupil should be full of reverence for his teacher, well-behaved, truthful, hard-working, obedient, free from pride and conceit and strong in faith. 3-7

Chemical operations are to be performed under the auspices of a ruler, who is God-fearing, who worships *S*iva and Pārvatī and whose territory is free from anarchy; and the Laboratory, to be erected in the depth of a forest, should be spacious, furnished with 4 doors and adorned with the portraits of the Gods. 13-15

Take of gold-leaf 3 *niskas* in weight and quick-silver 9 *niskas* and rub them with acids for 3 hours. Make the amalgam into a *phallus* (emblem of *S*iva, the creative principle).....................the *phallus* to be worshipped in due form. By the mere sight

of the *phallus* of mercury, the sins accumulated by the killing of 1,000 Brāhma*n*s and 10,000 cows are redeemed. 19-22

The science of mercury was communicated by *S*iva himself and is to be imparted by the instructor to the disciple according to the prescribed rules with closed eyes. 30

[Here follows an account of certain disgusting and obscene rites borrowed from Rasār*n*ava and other Tāntric works.]

The apparatus and implements as also the ingredients required for chemical operations (see next Book) are also to be addressed in prayer . . . . and the names of the 27 alchemists to be invoked. [See opening lines: Bk. 1, p. 77.] 53-61

The science of mercury is to be strictly kept a secret . . . . . if it is divulged, its efficacy is gone 70

BOOK VII

On the Laboratory

The Laboratory is to be erected in a region, which abounds in medicinal herbs and wells . . .

. . . it is to be furnished with the various apparatus. The *phallus* of mercury is to be placed in the east, furnaces to be arranged in the south-east, instruments in the south-west; washing operations in the west; drying in the north-west. . . . . The koshṭī apparatus for the extraction of essences, the water vessels, a pair of bellows and various other instruments are slso to be collected as also the threshing and pounding mortars, the pestles, sieves of various degrees of fineness, earth for the crucibles, charcoal, dried cow-dung cake, retorts made of glass, earth, iron and conch-shells,[1] iron-pans, &c. 1-18

Those who are truthful, free from temptations, given to the worship of Devas and Brāhmaṇas, self-controlled and used to live upon proper diet and regimen—such are to be engaged in performing chemical operations. 30

Such herbalists as are not deceitful and are well-versed in the knowledge of the drugs and plants and in the language of many countries should be employed. 32

(1) Probably lime crucibles and retorts are meant.

BOOK VIII

ON TECHNICAL TERMS

For the comprehension of ignorant physicians, Somadeva[1] is now expounding the technicalities as made use of by experts. 1

The physician is entitled to half the share of prepared mercury and eighth part of medicated oils and *ghee* and seventh part of prepared iron and other metals. 2

Mercuary, on being finely rubbed with melted sulphur and other minerals, attains the tint of collyrium and is called kajjali (see p. 61), which again on being rubbed with a liquid substance is known as Rasapanka (lit. mud of mercury). 5-6

TESTS FOR KILLED IRON.

Killed iron is that which in the shape impalpable powder floats on water and when rubbed between the thumb and the fore-finger enters the lines; which, on being mixed with treacle, *abrus p.*, honey

(1) The author evidently reproduces this chapter from a standard work on the subject by Somadeva. There is a work

and *ghee* and heated, does not revert to the natural state; which floats on water like a duck and does not sink down even when heavy things like paddy grains are placed over it. (Cf. *ante* p. 111, foot-note). 25-28

Killed iron (or a general in *killed* metal) is that which on being heated with silver does not mix (or alloy) with it.[1] 29

ANTIMONY FROM STIBNITE

Nīlāñjana,[2] mixed with tīkshnam (cast iron) and strongly heated several times, yields a superior kind of lead which is readily fusible and is of mild black colour. 38

[Here follows a list of metaphorical expressions which are technically used.]

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named Rasendrachūdámani by Somadeva. We hope to notice it in the second volume.

(1) The Poona ed. has रौप्येण मेलयेत् *mixes with silver*; but the Benares and the Kásmír Mss. read रौप्ये न मेलयेत् *does not mix with silver*. The latter is no doubt the correct reading.

(2) Stibnite. A synonym for it is souvirāñjana. The "superior kind of lead" is evidently antimony.

CERTAIN OTHER TECHNICAL TERMS

The resurrection of the dead is known as utthāpana (lit. raising).[1] 39

The capacity of mercury to swallow food [i. e. to combine with certain substances or to take up the qualities inherent in them] is known as grāsamānam. 64

Mercury, alloyed with one-sixty-fourth part of its weight of gold or silver acquires a mouth wherewith to swallow even hard metals. 68-69

Lepa, kshepa and kunta signify dhūma i. e. smoke. By the process of lepa is meant the conversion of iron into gold or silver. 80

The conversion of iron into gold or silver with the aid of mercury thrown into a smoky flame, emitting vapour, is known as dhūmavedha (lit. pierced by smoke). 83

The conversion of a small quantity of a metal into gold through the agency of mercury. . . . . which has acquired a mouth (see *s*loka 68), is called *s*abdavedha.[2] 84

(1) *e.g.*, the conversion of *killed* iron into the metallic state.

(2) It is to be regretted that the details of the processes have been withheld. We have here sufficient indication of the belief in the transmutation of metals. The processes here mentioned are probably of the same nature as given in Rasārnava.

Somadeva collected these brilliant gems of technical terms with great care from the ocean of mercurial lore and strung them into a necklace which adorns the best of physicians in assemblies. 89

BOOK IX

ON APPARATUS THE (YANTRAS)[1]

Somadeva will now give a brief account of the apparatus after having consulted innumerable works on chemistry.[2] 1

DOLĀ YANTRAM

Dolā yantra*m* : a pot is half-filled with a liquid and a rod placed across its mouth from which is suspended the medicine tied in a piece of cloth. The liquid is allowed to boil and a second pot[3] inverted over the first. 3-4

(1) *Vide* illustrations : Appendix II.

(2) This chapter also is evidently quoted from the work of Somadeva.

(3) Unless otherwise stated earthen pots are meant.

SVEDANĪ YANTRAM

Svedanī yantram: a pot with boiling water has its mouth covered with a piece of cloth and the substance to be steamed is placed on it and a second pot arranged in an inverted position over the rim of the first. 5

PĀTANĀ YANTRAM

Pātanā yantram [lit. apparatus for sublimation and distillation]: two vessels are adjusted so that the neck of the one fits into that of the other. The junction of the necks is luted with a composition made of lime, raw sugar, rust of iron and buffalo's milk. [Tedious details are given as to the exact measurement of the vessels.] 6-8

ADHASPĀTANĀ YANTRAM

Adhaspātanā yantram: a modification of the above apparatus in which the bottom of the upper vessel is smeared with the substance, the vapour or essence thereof condensing into the water of the lower one. Heat is applied on the top of the upper vessel by means of the fire of dried cow-dung cakes. 9

Dhekī Yantram

Dhekī yantram : below the neck of the pot is a hole into which is introduced the upper end of a bamboo tube, the lower end of it fitting into a brass vessel filled with water and made of two hemispherical halves. Mercury mixed with the proper ingredients is subjected to distillation till the receiver gets sufficiently heated. 11-14

Vāluka Yantram (Sand-bath)

Vāluka yantram (sand-bath : a glass flask with a long neck containing mercurials, is wrapped with several folds of cloth smeared with clay and then dried in the sun. The flask is buried up to three-fourths of its length in sand and placed in an earthen pot whilst another pot is inverted over it, the rims of both being luted with clay. Heat is now applied till a straw placed on its top gets burnt. 34-36

Lavana Yantram

If in the above apparatus salt is substituted for sand, it is called lavana yantram (salt-bath). 38

Nālikā Yantram

If in the above an iron tube be substituted for the glass flask, it is called nālikā yantram. 41

Place the crucible containing chemicals inside a mass of sand and apply heat by means of cow-dung cakes. This is known as the Bhūdhara yantram.

Tiryakpātanā Yantram

Tiryakpātanā yantram (lit. distillation *per descensum)*: place the chemicals in a vessel provided with a long tube, inserted in an inclined position, which enters the interior of another vessel arranged as receiver. The mouths of the vessels and the joints should be luted with clay. Now urge a strong fire at the bottom of the vessel containing the chemicals, whilst in the other vessel place cold water. This (process) is known as tiryakpātanām. 48-50

Vidyādhara Yantram

Vidyādhara yantram is for the extraction of mercury from cinnabar. [Two earthen pots are

arranged as in the illustration. The upper one contains cold water and the mercury condenses at its bottom.] 57-58

Dhūpa Yantram

Dhūpa yantram (lit. fumigating apparatus): bars of iron are laid in a slanting position a little below the mouth of the lower vessel and gold-leaves are placed over them and at the bottom of the vessel is deposited a mixture of sulphur, realgar, orpiment, etc., A second vessel, with its convexity turned upwards, covers the mouth of the lower one and the rims are luted with clay. Heat is now applied from below. This is called fumigation of gold-leaves. Silver may also be similarly treated. 70-74

[This chapter concludes with a detailed description of mortars and pestles—their sizes, measurements, &c.]

BOOK X

On the Ingredients for Crucibles, &c.

Earth which is heavy and of a pale colour, sugar or earth from an ant-hill or earth which has

been mixed with the burnt husks of paddy, fibres of the hemp plant, charcoal and horse-dung pounded in an iron mortar and also rust of iron are to be recommended for crucible-making. 5-6

V*ṛi*ntaka Crucible

A crucible of the shape of the fruit of br*i*njal (*Solanum melong*) to which is attached a tubulure, which is expanded towards its mouth like the flower of *Datura s.*, . . . and which is either 12 or 8 digits in length, is suitable for the extraction of the essence of calamine and other readily fusible minerals. 23-24

[The particular kind of crucible described here is the same as referred to in the extraction of zinc from calamine in the couplets 157-161, Bk. II.]

[Here follows a tedious account of the different kinds of crucibles to be used for different chemical operations.]

Calcination, Roasting, &c.

When metals have undergone roasting they cannot be roasted to their former condition (*i.e.* they lose their own properties) and they acquire

superior qualities, fill up the lines in the fingers and do not sink in water.[1] 51

A quadrangular pit 2 cubits in length, breadth and depth respectively is filled with 1,000 cow-dung cakes. The drugs to be roasted are placed in one crucible; this is covered with a second, the rims being luted with clay. The crucibles are deposited over the cow-dung cakes and 500 more thrown over them: fire is now applied. 54-55

[The description given above is that of a typical roasting pit. The size of the pit, as also the number of cow-dung cakes often varies according to requirements. It is unnecssary to reproduce the *minutiæ*.]

The Metals

The six metals are: gold, silver, copper, tin, lead and iron. Kā*m*sya and pittala (see p. 114) are artificially made [*i.e.* alloys]. 70

The Salts

The six salts are: sāmudra*m* (lit. derived from the evaporation of sea-water); saindhava (or rock-

(1) Cf. VIII. 25-28; also ibid. 39, pp. 118-119.

salt); vi*dam*, sauvarchala, romaka and chulikā lava*n*a.[1]

The Alkalies

The 3 alkalies are: carbonate of potash, carbonate of soda (trona or natron) and borax. 71

The Oils

[A list of plants is given from the seeds of which oil is expressed.] 73-75

The Fats

The fats of the jackal, the frog, the tortoise, the crab, the dolphin, the ox, the pig, man and also of the goat, the camel, the ass, the ship and the buffalo are to be used. 76-77

The Urines

The urines of the elephant, the she-buffalo, the ass and the horse are to be used. (Cf. *ante* p. 30). 78

The Acids

The acids are: *rumex vesicarius*, the citrons

(1) A syn. for navasára (salammoniac), see p. 97.

and lemons, *oxalis corniculata,* tamarind, the acid exudation of *cicer arietinum, zizyphus jujuba,* pomegranate, *averrhoa carambola*—these are the acids well suited for the purification, dissolution and killing of mercury and the minerals.[1] 80-84

THE EARTHS

Brick, red ochre, saline deposits, ashes, earth from ant-hills—these 5 kind of earth are recommended by the experts. 85

THE POISONS

Kālakuta, aconite ferox, sringika and the biles of animals are the chief poisons. 86

The minor posions are :—*gloriosa superba, strychnos nux vomica, nerium odorum, anacardium semicarpus, datura stramonium, calotropis gigantea.*[2]

(1) See under Mineral Acids.

(2) The information on the poisons is most elaborate in Susruta from whom our author evidently borrows the classification as given later on in Bk. XV; namely : स्थावर, जङ्गम:, कृत्रिम: or vegetable, animal and artificial poison. It is worthy of note that opium is not included among the minor poisons.

9

The Solvents

Treacle, *bdellium*, *abrus precatorious*, clarified butter, honey, borax—these are used for helping the fusion of the most infusible metals and hence they are classed among the solvents. 100

BOOK XI

On the Purification of Mercury

I am now going to describe briefly the various processes for the purification of mercury after having consulted Rasārṇava and other works. 10

There are 3 natural impurities in quciksilver, visha (poison), vaṇhi (fire) and mala (dirt, dregs) and two artificial, due to its being alloyed with lead and tin.[1] 14-15

(1) Cf. Rasendrachintâmaṇi:

मिश्रितौ पेटकै नागवङ्गौ विक्रयहेतुना ।

ताभ्यां स्यात् कृत्रिमोदोषः तन्मुक्तिः पातनत्रयात् ॥

"Trades-people fraudulently adulterate quicksilver with lead and tin, hence it is to be freed from these artificial defects [impurities] by means of three distillations" as given above under Tiryakpâtanâ (p. 124).

Hence for the purification of mercury, the operations (named below) are to be undertaken with the aid of appliances and skilled assistants. 20

In an auspicious day and under the influence of a benign star, a quantity of mercury weighing 2,000 or 1,000 or 100 or 18 or 10 *palas* is to be taken and the operation begun. 21-22

[It is useless to enter into the details of the several processes described here; they are more or less repetitions of what has already been given.]

Pātanavidhi: [purification of mercury by distillation as described in the foot note p. 130.] 33

FIXATION OF MERCURY.

Rasavandha: processes for destroying the fluidity of mercury:

Take mercury and one-fourth its weight of *killed* gold and with the addition of sulphur make a ball. Now add an equal weight of sulphur and roast the mass in a covered crucible.[1] 72

The mercury thus treated is afterwards killed

(1) In other works a glass retort is recommended.

with six times its weight of sulphur.[1] 73

INCINERATION OF MERCURY

[The chapter concludes with certain recipes for the killing of mercury, with the aid of purely vegetable products.]

Mercury, roasted in a covered crucible with asafœtida, which has been previously digested in the milky juice of *ficus oppositifolia*, is reduced to ashes.[2] 111

Andropogon serratus and *clitorea ternatea* are to be pounded in a mortar with sour gruel and with the paste thus formed, mercury is to be triturated and digested 7 times and finally roasted in

(1) The shining reddish brown crystalline sublimate of sulphide of mercury thus obtained is a favourite and frequently-used remedy with the Hindu physicians. It is reputed to be a panacea for a variety of ills that flesh is heir to. In the "Rasendrachintámani," "Rasendrasárasamgraha" and other treatises, this preparation is described as "Makaradhvaj" and "Rasasindúra" (lit. minium-like mercury). From the supposed presence of gold it is often named "Svarnasindúra" (lit. gold and vermilion). During sublimation, the gold of course is left behind. The general belief is that by association with gold the mercury acquires most potent efficacy. A later work, Rasapradípa, is sceptical about the part which gold plays and recommends its being left out.

(2) *Sárngadhara* also gives a similar recipe.

a covered crucible after addition of fresh quantities of the above paste. The mercury is reduced to ashes, resembling salt. 112-113

The seeds of *achyranthes aspera* and *ricinus communis* are to be pounded together. The mercury is to be placed inside the powder and the mass roasted as before. The mercury is reduced to ashes.[1] 114

Purified mercury is to be preserved in the hollow of a horn or tooth or of bamboo. 119

* * * * *

Here ends chapter XI of "Rasaratnasamuchchaya," which treats of the purification fixation and incineration of mercury.

Notes on the Minerals

Diamond: Belief in the combustibility, of diamond (*vide* pp.101-2) was an accepted creed with

(1) Cf. Rasendrachintámaṇi, which evidiently quotes from a Tántric work: "O Goddess, I shall now enumerate the substances which *kill* mercury, without the use of sulphur." A list of 41 plants is given of which any ten may be employed at a time for the roasting operation. The names of the following among others occur in the list: *vitis quadrangularis, andropogon serratus, plumbago zeylanica, clitorea ternatea,* milky juice of *calatropis gigantea* and of *euphorbia neriifolia; vitex negundo, datura stromonium, achyranthes aspera, ficus oppositifolia and tinospora cordifolia*

the Hindu Iatro-Chemists. The reader will find much useful information in the followng extract.

'This combustibility of the diamond appears to have been observed at an early period, although the fact does not seem to have attracted the general attention of the older chemists, as statements of a contrary character are recorded by them. Thus, for instance, Kunkel states that his father, at the command of Duke Frederick of Holstein, heated diamonds in his gold-melting furnace, for nearly thirty weeks, without their undergoing any change. It is to Newton, however, that we owe the first argument which went to prove that the diamond was capable of undergoing combustion on account of its high refractive power, a property characteristic of the class of oily bodies. In the second book of his *Opticks*, Newton says upon the subject, "Again the refraction of camphire, oyl-olive, lintseed oyl, spirit of turpentine and amber, which are fat sulphureous unctuous bodies, and a diamond, which probably is an unctuous substance coagulated, have their refractive powers in proportion to one another as their densities without any considerable variation." The conclusion to which Newton was led by theoretical considerations was experimentally proved to be correct in the year 1694-5 by Averami

and Targioni, members of the Academia del Cimento, who, at the request of the Grand Duke Cosmo III., of Tuscany, placed a diamond in the focus of a large burning-glass and observed that it entirely disappeared. Francis I., who is said to have received from an alchemist an anonymous receipt for melting diamonds, exposed, in the year 1751, diamonds and rubies of the value of 6,000 gulden for twenty-four hours to the action of a powerful fire; the rubies were found unaltered, but the diamonds had altogether disappeared. The volatilization of the diamond by means of heat was from this time forwad made the subject of numerous experiments. Thus, Darcet observed in 1766 that diamonds disappear when they are heated in a cupel-furnace, even in closed crucibles, but, continuing his experiments at the request of the Paris Academy, he, together with Rouelle, found that when heated in perfectly hermetically-sealed vessels, the diamond did not disappear. Macquer, in the year 1771, was the first to observe that when the diamond undergoes volatilization it appears to be surrounded by a flame. In conjunction with Cadet and Lavoisier, he afterwards found that a true combustion takes place. In continuation of these experiments Lavoisier, together with Macquer, Cadet,

Brisson, and Baumé,[1] placed a diamond in a glass vessel containing air collected over mercury, and on igniting the diamond by means of a burning-glass, they found that carbonic acid gas was produced."—Roscoe and schor. Vol I. pp. 658-59.

Mr. T. H. Holland, F.G.S., A.R.S.M., of the Geological Survey of India, to whom was submitted the translation of the descriptions of the minerals (*vide* pp. 79-100), has favoured me with his opinion, which is reproduced below in his own words. It will, to a certain extent, help in the identification of the minerals.

"I have appended notes giving suggestions which may help to explain some of the passages, but the majority of descriptions are altogether too vague to permit identification of the minerals. The names of minerals already given are presumably recognised translations; for the descriptions accompanying the names might just as well, in many instances, apply to several minerals known in this country.

"Vaikrānta has 8 faces and 6 angles" &c., (p. 83) possibly refers to a mineral crystallizing in the octahedral form, and of the many minerals crystallizing in this form the family of spinels is

(1) Lavoisier : *Œuvres*, tome ii. 38, 64.

more likely to exhibit the great range of colours given.

"White"—Unknown.

"Red"—Ruby spinel.

"Yellow"—Rubicelle (orange to yellow): dysluite (yellowish brown).

"Blue"—Almandine (violet).

"Grass-green"—chlorospinel, hercynite (black when massive, green by transmitted light and in powder), pleonaste (dark-green);

"black"—magnetite, gahnite, franklinite &c.;

"variegated"—some magnesia spinels;

8 Faces and 6 angels" might possibly also refer to the hexagonal prism with basal planes, a common form of corundum, which gives the variety of colours referred to even more perfectly than the spinels.

But the remarks on p. 104 as to the "liquefaction" of this mineral, cannot apply to either spinel or corundum. Unless there is some failure to appreciate the original meaning the statements are nonsensical.

Mākshika*m* (pyrites) . . . . Pyrites is of two kinds—golden and silvery; the former is a native of Kanauj, and is of golden yellow colour. The silvery pyrites is associated with stones and

is of inferior quality."

Mâkshika repeatedly steeped in [organic substances] and gently roasted in a crucible yields an essence of the appearance [in the shape] of copper" (p. 84.)

Iron pyrites [$Fe S_2$] is brass-yellow in colour, and its dimorphous form marcasite is pale bronze-yellow; but there are other pyrite-like minerals which are silvery white; for instance, cobaltite ($Co S_2 . Co. As_2$), smaltite ($Co As_2$), löllingite ($Fe As_2$ with S) and leucopyrite ($Fe_3 As_4$). Iron pyrites roasted in air would give a red residue of $Fe_2 O_3$. But it seems more likely that the "golden-yellow" variety is copper-pyrite, which has a deep yellow colour and besides which iron-pyrite when freshly fractured would appear almost silvery in colour. In that case the "essence of the appearance of copper" might be the metal itself.[1]

"Sasyaka (blue vitriol) has the play of colours in the throat of the peacock." (p. 86.)

The experiments referred to might apply to any copper compound. There is a copper ore, bornite or erubescite ($Cu_3 Fe S_3$), which, on account of its

(1) Vimala (pp. 84-85) would appear also to be a variety of pyrites.

peculiar colour and iridescence, is known as "peacock" ore. It occurs in several parts of India.

Gairika: hematite, which is red and often hard, and limonite which is yellow or brown, both occur in the form of ochres.

'Ka*m*kush*th*a*m* is produced at the foot of the Himālayas . . . it is of white and yellow colour and is a strong purgative."

Possibly an efflorescence of magnesium sulphate or sodium sulphate; both are not uncommon. The yellow colour might be due to admixture with ferruginous dirt due to oxidation of the ferrous sulphate produced by similar causes with the other sulphates.

Vajra*m*: the remarks "8 faces and 6 corners" would be correct for an octahedral crystal of diamond; but I know of no crystal form which has at the same time "8 angles." The faces of the diamond are frequently rounded, which may account for the statements about the "female" and "neuter" diamonds. Many transparent minerals give a play of colours through either schillerization or refraction; but the diamond is of course particularly noticeable on account of its high dispersive power."

The following extracts from Ball's "Economic Geology of India" will also throw considerable

light on this subject. It will be seen how in India the traditions of the technical arts of which we get vivid glimpses in the Rasārnava have been preserved even to our own days from time immemorial.

"Rājputanā—Copper ores are found in several of the independent States of Rājputanā, and also in the British district of Ajmīr. Mining has been practised on a large scale, but at present the trade of miner is becoming extinct and the operations, which are only carried on in a few of the localities are of a very petty nature.

"The names of the States in which there are mines are as follows: Alwar, Bhartpur, Jaipur, Udepur, Bundi and Bikanir.

"Alwar State.—According to Mr. Hacket there are ancient copper mines at the following localities in this state: Daribo, Indawas, Bhangarh, Kusalgarh, Beghani, Pratabgarh, Tassing, and Jasingpura. The most important of this is the first.

"Deribo.—The mine is situated on a sharp anticlinal bend in a thin band of black slates intercalated in the Alwar quartzites. There appears to be no true lode; the one, which is pyrites mixed with arsenical iron, occurs irregularly disseminated through the black slates, â few specks and stains only being seen in the quartzites; occasionally rich

nests of ore were met with . . . . . From an interesting account by Major Cadell, the following facts regarding the manufacture have been extracted. The ore, as usual in the native process, is pounded, made up into balls with cow-dung, roasted, and then smelted in a closed furnace and refined in an open charcoal fire. Thirty pounds of ore require four times that quantity of charcoal and yield 5½ pounds of metal, or 16.6 per cent. During the last 12 years the average annual outturn has been only 3 tons 8 cwts., and it is diminishing owing to the influx of European copper.

"Singhana (Jaipore State).—The copper mines at Singhana are situated in rocks belonging to the Arvali series. The earliest account of these mines, which is believed to have been by Captain Boilcan, was published in the year 1831. The principal productions were copper, blue vitriol or copper sulphate, alum, and an ore of cobalt called *sehta* or *saita*.

"The mines are described as being tortuous and of great extent; at the working faces it was the custom to light fires which caused the rock to split up. Lamps were used which the miners carried on their heads and with a gad and hammer extracted the ore. The principal ore found appears

to have been pyrites. It was sold retail by auction to the proprietors of different furnaces.

"The pounding or crushing was effected on a stone anvil with a hammer weighing eight or ten seers; when completely reduced to powder the ore was made up into balls with cow-dung and roasted. The blast furnaces (*vide illustrations*) were prepared in the following manner. A quantity of common sand was spread on the door of a circular hut, in the centre of which a depression, 12 to 15 inches in diameter and 2 or 3 inches deep, was made; in this a layer of fine sand and another of ashes were laid to prevent the metal from adhering to the bottom of the receiver; two clay nozzles or tuyèrs were then placed on opposite sides of this hollow and a third between them, leaving the fourth side vacant for the slag to escape. The nozzles were then connected by moist clay and a circular rim of mud, a few inches in height, was raised, on which three annular vessels of fire-clay were placed to form the body of the furnace, each of these was 15 inches in external diameter, 10 inches high, and 3 inches thick. They were used repeatedly, but the lower part of the furnace had to be reconstructed for every charge. The bellows were simply goat-skins connected with the nozzles,

and were worked by the families of the smelters. After a preliminary firing, to dry the mud, the furnace was charged with charcoal, roasted ore and iron slag, the latter being employed as a flux.

"In a day of nine or ten hours' duration, 3 maunds of charcoal, 2½ of the roasted ore, and 2 of the iron slag were consumed. The slag was drawn off and the smelted copper which had accumulated at the bottom of the furnace was removed on the following day. It was then re-melted and refined in an open furnace under a strong blast from bellows, and cast into small bars or ingots, which were subsequently removed to the Mint and cut up and fashioned into coins.

"The ore was said to yield only from to 2½ to 7½ per cent. of metal, but the profits must have been not inconsiderable as the Khetrī Rājā is said to have claimed one-sixth of the value of the copper in addition to Rs. 14,000 received for the lease. The quality of the metal is said to have been inferior to that of Basawar, this being attributed to the use of the iron slag as a flux . . . . Considerable quantities of blue vitriol (copper sulphate), alum, and copperas (iron sulphate) are manufactured from the descomposed slate and refuse of the mines. The slates are

steeped in water, which is afterwards evaporated in large iron vessels, when the blue vitriol, is crystallized out, afterwards the alum, and lastly the copperas. Mr. Mallet found traces of nickel and cobalt in all three of these substances.

"Copper smelting in the Singhbhum District (Bengal).—Indications exist of mining and smelting having been carried on in this region from a very early period, and the evidence available, points to the Seraks or lay Jains as being the persons who, perhaps 2,000 years ago, initiated the mining.[1] The number and extent of the ancient workings testify to the assiduity with which every sign of the presence of ore was exploited by these early pioneers and those who follow them up to recent times."

The Treatise on Alchemy attributed to Bubacar (10th to 11th century A. D.) also contains many similar descriptions of the gems and minerals; specially noticeable is the classification according to sex—*male* and *female* (cf. Bk. IV, 27-28, p. 100). We append below one or two short extracts.

"Viennent ensuite les treize genres de pierres, savoir: les marcassites, les magnésies, les tuties,

(1) Proc. As. Soc. Bengal, June 1869, p. 170.

l'azur (lapis lazuli ou cinabre ?), l'hématite, le gypse, etc., et toute une suite de minéraux désignés sous des noms arabes. Parmi les marcassites (sulfures), on distingue la blanche, pareille à l'argent ; la rouge ou cuivrée ; la noire, couleur de fer ; la dorée, etc.

"Les magnésies [1] sont aussi de différente couleur, l'une noire, dont la cassure est cristalline,[2] une autre ferrugineuse, etc. Une variété est dite mâle ; une autre, avec des yeux brillants, est appelée femelle ; c' est la meilleure de toutes.

"Les tuties [3] sont de différentes couleurs : verte, jaune, blanche, etc."

"La *classe des vitriols (atramenta)* comprend six espèces : celui qui sert à faire du noir, le blanc, le calcantum, le calcande, le calcathar, et le surianum. Il y en a un jaune, employé par les orfèvres ; un vert mêlé de terre, employé par les mégissiers, etc."—"La Chimie au moyen âge," T. I., 307.

(1) Ce mot désignait certains sulfures et oxydes métalliques, tels que les oxydes de fer magnétique, le bioxyde de manganèse, etc.

(2) Offre des yeux brillants.

(3) Oxydes et minerais de zinc, renfermant du cuivre.

ALUM AND GREEN VITRIOL

Dutt speaking of alum states: "it is not mentioned by Su*s*ruta, in his list of metallics, but later writers give its synonyms and uses." This is evidently incorrect. Alum, with green vitriol, is distinctly referred to in the Su*s*ruta, *e. g*:

काशीसं त्रिफलादन्ती हरितालं सुराष्ट्रजा ।

Sûtra. xxxvi, 12.

In the above *s*loka *surāshtrajā*, lit., begot of Surāshtra (modern Surat), is used in the sense of alum. From the ancient times the "earth of Surat" has been known to yield this mineral. Amara Si*m*ha in his Lexicon, written sometime between 400-600 A. D.,[1] gives among others the following synonyms of alum:—kā*m*kshī, tuvarī and surāshtrajā. "Rasaratnasamuchchya" also gives the same synonyms. (Bk. III., 59-62). The manufacture of alum survives to our own days, as the following description will show:

"Alum shales, so called, are of rare occurrence in peninsular India, and, so far as it known, the

(1) The lowermost limit of his age may be taken about 948 A. D. as made out from an inscription in Budh Gaya.

only considerable native manufacture is situated in Rājputana; but as will be gathered from what follows, the tertiary rocks of the extra-peninsular regions often contain such shales.

"In two localities 'lumps of alum...occur naturally in sufficient abundance to be a regular article of export.

"Alum is principally used as a mordant in dyeing, but as a drug its employment is extensive in India.

"BEHAR.—Captain Sherwill in 1846 [1] stated that a small quantity of alum was manufactured from slates obtained in the district of Shahabad; these rocks, it is believed, belonged to the Bijigrah pyritous shales of the Kaimur group of the Vindhyan series.

"The alum was sold at the high price of one rupee per *tola*; it was identical with the *salajit* of Nepal. Copperas or iron sulphate is obtained in the same region, which is situated to the north of Rotasgarh, and to the west of the Sone.

"Rājputana, Khetri, and Singhana.—In connection with the copper mines at the above localities

(1) Journ. As. Soc. XV., p. 58.

there are manufactories which turn out considerable quantities of blue vitriol (copper sulphate), copperas (iron sulphate), and alum. The process has been very fully described and illustrated by Colonel Brooke. In 1864 there were twenty of these factories at Khetri and about double the number at Singhana. The broken shale from the mine which contains the salts is placed in earthen *gharas,* together with the crusts from the refuse heaps of previous lixiviations and water is added. The *gharas* are arranged on ledges prepared for the purpose on the heaps of refuse, as will be seen by reference to the wood-cut *(vide illustrations)*.

"Each charge of shale is exposed to three changes of water and the water itself is changed from one *ghara* to another till it has taken up the sulphates from seven different steepings. It is then of a thick dirty-bluish colour and is taken to the boiling house, where it is boiled in earthen *gharas;* when sufficiently concentrated it is left to cool, and thin sticks being introduced the blue vitriol crystallizes on them. The mother liquor is then poured off and again boiled, and on the addition of saltpetre, the alum crystallizes at the bottom of the vessel. The residual sulphates still in solution, are allowed to crystallize out by ex-

posing the mixture to the sun.

* * * * *

"CUTCH.—There are numerous accounts of the manufacture of alum in Cutch. The earliest is by Captain Mc Murdo, who states that before 1818 the exports of alum amounted in some years to several hundred thousand maunds, which chiefly went to Guzerat and Bombay to be employed in dyeing. The following account by Mr. Wynne is the most recent and complete. The site of the operations is at Mhurr or Madh.

"The rock containing the materials is a pyritous dark-gray or black shale, which is in close association with a soft aluminous pseudo-breccia of the sub-nummulitic group.

"This shale is excavated from pits and is exposed for four months, a slow combustion taking place owing to the decomposition of the pyrites.

"It is then spread in squares resembling salt pans and sprinkled with water. After about 12 days it consolidates into efflorescing mammillated crystalline plates or crusts called *phitkari-ka-bij* or seed of alum. These crusts are boiled in large iron vessels (luted inside with lime), together with saltpetre (or other potash salt), in the proportion of 15 of 'alum seed' to 6 of the latter; when it has

settled, the liquor is placed in small earthen vessels somewhat the shape of flower-pots, and crystallization takes place in three days. These crystals are again boiled one or more times to concentrate the solution, which is finally ladled into large thin bladder-shaped earthen *mutkās* or *gharās* with small mouth; these are sunk into the ground to prevent their breaking, and in five days the alum is found crystallized in masses. The vessels are then broken and the alum is stored.

"Alum is also manufactured from the water of a hot spring north of Mhurr. The impure saltpetre, which is employed to supply the second base in the above-mentioned manner, is obtained by lixiviation of village refuse." (Ball's "Economic Geology", pp. 431-33).

"IRON SULPHATE.—The green vitriol or copperas of commerce which is known to the natives as *kahi* and *hara kāsis*, is produced principally from the so-called alum shales from which alum is prepared. As is the case also with alum, copperas is found sometimes as a natural exudation upon alum shales and other rocks which include iron pyrites.

"This native copperas goes by several different names in India, according to the nature of the other substances with which it is combined.

"BEHAR.—In the year 1833, Mr. J. Stevenson, published an analysis of native sulphate of iron obtained from Behar, which was at that time used by the native dyers of Patna.

He found that it consisted of—

Iron sulphate	39·0
" peroxide	36·0
Magnesia	23·0
Loss	2·0
	100·0

ibid p. 419.

On Metals and Metallurgy

In the Vedic Period gold and silver were not only known but were worked into ornaments of various descriptions. Gold was often called by the name "yellow" and silver by the name "white." The warriors of old were protected with coats of mail and helmets of metal. 'Loha" was a term applied to the metals in general though in later ages it came to stand for iron alone. In the Vedic literature iron proper seems to be designated by krishnáyas or the black metal and copper by lohitáyas or the red metal.[1]

Besides gold and silver, several other metals, *e.g.* iron, lead and tin, are mentioned in the White

(1) हरिते त्रीणि रजते त्रीण्ययसि त्रीणि तपसाविष्ठितानि । AV. 5, 28, 1. Here "हरित" (yellow) is explained by Sáyana as equivalent to gold. श्याममयोऽस्य मांसानि लोहितमस्य लोहितम् । AV. 11, 3, 7. Here according to Sáyana श्याममयः – black metal *i. e.* iron and लोहितमयः – red metal *i.e.* copper. The Suruta also differentiates iron by the term krishnaloha (black metal), though copper is known by its proper name támra.

Yajurveda: हिरण्यं च मे, अयश्च मे, श्यामं च मे, लोहं च मे, सीसं च मे, त्रपु च मे यज्ञेन कल्पन्ताम्। XVIII, 13.

In the Chhāndogya Upanishad IV, 17.7. we also read: "as one binds gold by means of lavaṇa (borax), and silver by means of gold, and tin by means of silver, and lead by means of tin, and iron by means of lead, and wood by means of iron, and also by means of leather." लवणेन सुवर्णं संदध्यात्, सुवर्णेन रजतं, रजतेन त्रपु, त्रपुणा सीसं, सीसेन लोहं, लोहेन दारु, दारु चर्मणा।

Unfortunately very little material is now available to enable us to present a connected narrative of the metallurgical skill of the ancient Hindus. Many important links are missing; we shall here try to put together only a few, which we have been able te recover.

Megasthenes says that the Indians were "well skilled in the arts." According to the Greek writer, the soil too has "underground numerous veins of all sorts of metals, for it contains much gold and silver, and copper and iron in no small quantity and even tin and other metals, which are employed in making articles of use and ornament, as well as the implements and accoutrements ofwar."

Coming to comparatively later times, we find that the Indians were noted for their skill in the

tempering of steel. The blades of Damascus were held in high esteem but it was from India that the Persians and, through them, the Arabs learnt the secret of the operation.[1]

The wrought-iron pillar close to the Kutub near Delhi which weighs ten tons and is some 1500 years old; the huge iron girders at Puri; the ornamental gates of Somnath and the 24-ft wrought-iron gun at Nurvar—are monuments of a bye-gone art and bear silent but eloquent testimony to the marvellous metallurgical skill attained by the Hindus. Regarding the Kutab pillar, Fergusson says: "It has not, however, been yet correctly ascertained what its age really is. There is an inscription upon it, but without a date. From the form of its alphabet, Prinsep ascribed it to the 3rd or 4th century; Bhau Daji, on the same evidence, to the end of the 5th or beginning of the 6th century. The truth probably lies between the two. Our own conviction is that it belongs to one of the Chandra Rajas of the Gupta dynasty, either subsequently to A. D. 363 or A. D. 400.

(1) *Vide* Trempe du Fer Indien: "Elle a *été* découverte par les Indiens et exposée par les Perses, et c'est de ceux-ci qu'elle nous est venue."—Berthelot: "Coll. Alch Grec.," T. 3, *trad.* p. 332.

"Taking A. D. 400 as a mean date—and it certainly is not far from the truth—it opens our eye to an unsuspected state of affairs to find the Hindus at that age capable of forging a bar of iron larger than any that have been forged even in Europe up to a very late date, and not frequently even now. As we find them, however, a few centuries afterwards using bars as long as this *lat* in roofing the porch of the temple at Kanaruc, we must now believe that they were much more familiar with the use of this metal than they afterwards became. It is almost equally startling to find that after an exposure to wind and rain for fourteen centuries, it is unrusted, and the capital and inscription are as clear and as sharp now as when put up fourteen centuries ago.

"There is no mistake about the pillar being of pure iron. Gen. Cunningham had a bit of it analysed in India by Dr. Murray, and another portion was analysed in the School of Mines here by Dr. Percy. Both found it pure malleable iron without any alloy." "Hist. of Indian and Eastern Architecture," p. 508 ; ed 1899.

The Ritter Cecil von Schwarz, who was for sometime in charge of the Bengal Iron Works Company, thus speaks of the superior iron smelting

industry in India :—

"It is well-known by every manufacturer of crucible cast-steel how difficult it is sometimes to get the exact degree of hardness to suit certain purposes, especially with reference to steel for cutting the blades, etc., With the ordinary process, endeavours are made to reach the required degree of hardness by selecting such raw materials as on an average have the required contents of carbon in order to correspond with the required degree of hardness as far as possible. The natives [of India] reached this degree by introducing into their cast-steel an excess of carbon, by taking this excess gradually away afterwards, by means of the slow tempering process, having it thus completely in their power to attain the extact degree by interrupting this de-carbonsing process exactly at the proper time in order to cast steel of a quality exactly suitable for the purpose."

ZINC

The extraction of zinc from the ores can be followed in every detail from the account left us both in "Rasārṇava" and "Rasaratnasamuchchaya."

"Rasaka" is mentioned in Rasārṇava as the mineral which turns copper into gold (p. 71). We have also in the succeeding couplets a process described for the reduction of the ore. This process is so elaborately given in R. R. S. that it may be quoted almost *verbatim* in any treatise on modern chemistry; it is practically the same as distillation *per descensum*—the flame of bluish tint issuing from the mouth of the crucible indicates the combustion of carbon monoxide, so often observed in metallurgical operations.[1] (See p. 88).

From the time of the Suśruta to that of R. R. S., we find all along six metals recognised (see pp. 48 and 127) and the last work distinctly mentions brass and bell-metal as simply alloys. Owing to the veneration paid to ancient authorities, the Indian alchemists had at first some hesitation in classing "the essence of the lustre of tin "[illegible]" (p. 71) as a separate metal. In the medical Lexicon ascribed to king Madanapāla and written about the year

(1) Cf. "A mixture of 2 parts of ground roasted ore and 1 part of coal dust is brought into the retorts, each holding about 40 lbs. of the mixture. As soon as the temperature has risen high enough, the reduction begins and *carbon monoxide is evolved and burns* from the end of the clay adapter *with a blue flame* (the italics, are ours). Roscoe and Schorlemmer's Chemistry, Vol. II., Pt. I p. 255, ed. 1879.

1374 A. D.,[1] zinc is, however, distinctly recognised as a metal under the designation of *Jasada.*[2]

It it evident rasaka is the cadmia of Dioscorides and Pliny and tutia of the alchemists of the middle ages. The pseudo-Basil Valentine writing about 1600 A. D. uses the word zinc but "he does not appear to have classed it with the metals proper." Paracelsus mentions zinc sometimes as a metal and sometimes as a *bastard* or *semi*-metal, but it is doubtful whether he had any distinct notion of its true character specially as he says, "it has no malleability" (keine malleabilität hat er) or of the ore which yielded it.[3] "Libavius was the first to investigate the properties of zinc more exactly, although he was not aware that the metal was derived from the ore known as *calamine.* He states that a peculiar kind of tin is found in the East Indies called Calaëm. Some of this was brought to Holland and came into his hands." (Roscoe and Schorlemmer).

The terms rasaka, kharpara, kharpara-tuttha

(1) Roth: "Indischen Studien," XIV, 399; also Bühler: Intro. to Manu, CXXV.

(2) जसदं रङ्गसदृशं रीतिहेतुश्च तन्मतम् ।

(" Gesch. d. Chemie," IV, 116.

and tuttha are all applied to calamine, while tuttha sometimes stands for blue vitriol as well. Some writers have, however, mistaken kharpara for blue vitriol, but R. R. S. is very explicit on this point. The name *tutenague* by which Chinese zinc was known in commerce is evidently derived from the Tamil *tatanagam*. "In Persian, sulphate of zinc is called *suffed* (white) *tutia*; sulphate of copper, *neela* (blue) *tutia*; and sulphate of iron, *hura* (green) *tutia*; so, in Avicenna, different kinds are described under this name, which occurs also in Geber" (Royle). Both the Tamil *tatanagam* and the Persian *tutia* are probably corruptions of the Sanskrit word *tuttham*. At the beginning of the last century the Baron de Sacy was at considerable pains in tracing the history of *tutia*. In a note appended to certain extracts from Kazwini, the "oriental Pliny," the learned Frenchman gives the following description of *tutia*. The account necessarily involves some digressions on the Aristotelian theory of the formation of dew, hailstone, metals, &c., and the reader may with advantage compare it with that of the Vaiseshika Philosophy. (Chap. 1, pp. 1-12).

"Le *khar-sini* est aussi nommé *fer de la Chine* . . . et *or cru* . . . Je crois que ce même

métal est aussi désigné sous les noms de *djosd* ou *djost* dans l'Inde, de *tutie fossile* . . chez les Arabes, enfin d'*esprit de tutie* . . . . . dans l'*Ayin Acbéri*, et que c'est la *toutenague*, dont il y a plusieurs variétés plus ou moins analogues au zinc.

"Je vais rapporter, pour mettre le lecteur à portée de juger de ma conjecture, ce que je trouve dans le Dictionnaire des médicamens simples par Ebn-Beïtar, sur les diverses espèces de tutie fossile, et un article curieux de l'*Ayin Acbéri*, omis pour la trèsgrande partie dans la traduction angloise de M. Gladwin ; j'en donnerai le texte d'après deux manuscrits de cet ouvrage, dont l'un m'appartient, et l'autre faisoit autrefois partie de la bibliothèque de feu M. Langlès et d'après le Traité de médecine, dédié au prince Dara-schékouh, où il se trouve tout entier (manuscrit de M. Brueix, acquis par la bibliothèque du Roi, n.° 16, fol. 62 et suiv.) Je joindrai à cela ce que dit Kazwini de la formation du *khar-sini* et de ses usages médicaux et économiques, laissant aux minéralogistes à juger si, dans ces descriptions mêlées d'hypothèses arbitraires, et de quelques traits suspects de charlatanisme, on peut reconnoître la toutenague.

"Voici d'abord le passage d'Ebn-Beïtar.

"Edu-Wafid dit : il y a deux espèces de tuties ; l'une se trouve dans les mines, l'autre dans les fourneaux où l'on fond le cuivre, comme la *cadmie* ; cette dernière espèce est ce que les Grecs nomment *pompholyx*. Quant à la tutie fossile, il y en a trois variétés ; l'une blanche, l'autre verdâtre, la dernière d'un jaune fortement rougeâtre. Les mines de celle-ci sont dans les contrées maritimes de la mer de Hind et de Sind : la meilleure est celle qui semble au coup-d'œil couverte de sel ; après celle-ci, la jaune ; quant à la blanche, elle a quelque chose de graveleux . . . . : et est percée : on l'apporte de la Chine. La tutie blanche est la plus fine de toutes les variétés et la verte, la plus grossière ; quant à la tutie des forneaux, Dioscoride dit, livre V.e. : *Le pompholyx, qui est la tutie, diffère du spodion &c.*"

"L' *Ayin Acbéri* expose la formation des minéraux et celle des métaux en particulier, suivant une hypothèse, commune, je crois, à tous les alchimistes anciens ; et quoique ces détails méritent par eux-mêmes peu d'attention, je rapporterai le passage en entier, 1.° prace que M. Gladwin l'a omis ; 2.° parce qu'il est nécessaire pour que l'on puisse juger de la nature du *kharsini*, et de l'identité que je suppose entre cette

substance métallique et l'*esprit de tutie.* Il y a dans le texte de l'*Ayin Acbéri* quelques omissions que je rétablirai d'après le Traité dédié à Dara-schékoüh, où ce chapitre se trouve tout entier, et il n'est pas le seul qui soit commun à ces deux ouvrages. L'auteur de ce dernier traité,........... ...., annonce lui-même, fol. 62, *verso,* qu'il va tirer quelques chapitres sur les métaux, de l'ouvrage de feu Abou'l Fazel, formant le III.e tome de l'*Acber-naméh* : l'un de ces textes me servira à corriger l'autre.

De la formation des métaux.

"Le dieu créateur de l'univers a donné l'existence à quatre élémens en opposition les uns aux autres, et il a suscité quatre êtres d'une nature admirable : le feu chaud et sec, qui possède une légèreté absolue ; l'air chaud et humide, doué d'une légèreté relative ; l'eau froide et homide, qui possède une pesanteur relative, la terre froide et sèche, douée d'une pesanteur absolue. La chaleur produit la légèreté, et le froid la pesanteur ; l'humidité facilite la séparation des parties, la sécheresse y met obstacle. Par la combinaison de ces quatre puissances élémentaries, ont été produits tous les êtres dont l'existence est due

l'influence des corps célestes, les minéraux, les végétaux et les animaux.

"Les particules aqueuses, ayant acquis par les rayons du soleil et autres causes un plus grand degré de légèreté, se mêlent avec les particules aériennes, et s'élèvent en l'air: c'est cette combinaison que l'on nomme *vapeurs.* Par le moyen de cette combinaison, les molécules terreuses étant mêlées elles-mêmes avec les particules aériennes, s'élèvent aussi en l'air; et c'est ce qu'on nomme *exhalaisons*: quelquefois aussi les particules aériennes se mêlent [immédiatement] avec les molécules terreuses. Il y a des philosophes qui appliquent également le nom de *vapeurs* à ces deux sortes de combinaisons élémentaires: ils désignent celles qui sont le produit des particules aqueuses, par le nom de *vapeures humides* ou *aqueuses*; et celles qui doivent leur formation aux molécules térreuses, par le nom de *vapeurs sèches* ou *fuligineuses.* Ce sont ces deux sortes de vapeurs qui forment au-dessus de la terre les nuées, le vent la pluie la neige et autres phénomènes semblables; et dans l'intérieur du globe, les tremblemens de terre les sources et les mines. On regarde les vapeurs comme le corps, et les exhalaisons comme l'esprit: des unes et des autres, suivant la diversité de leurs

combinaisons et les différentes proportions dans lesquelles elles s'unissent, sont produites dans le laboratoire de la nature un grand nombre de substances diverses. Suivant ce qu'on lit dans les traités de philosophie, on ne compte pas plus de cinq espèces de minéraux: ceux qui sont infusibles à cause de leur sécheresse, comme le *yakout* ; ceux qui le sont à cause de leur humidité, comme le vifargent ; ceux qui se fondent promptement, mais qui ne sont ni malléable, ni combustibles, comme le vitriol ; ceux qui ne sont pas malléables, mais qui sont combustibles, comme le soufre ; ceux enfin qui sont malléables, mais incumbustibles comme l'or. La fusion d'un corps consiste dans la liquéfaction de ses parties, due à la combinaison de la sécheresse et de l'humidité : la malléabilité [ou ductilité] est la faculté qu'a un crops de receivoir peu à peu une augmentation d'étendue, tant en longueur qu'en largeur, sans séparation d'aucune de ses parties et sans aucune addition.

"Quand les vapeurs et les exhalaisons se mêlent de manière que les premières soient le principe dominant, et que le mélange étant achevé et la coction parfaite, l'ardeur du soleil coagule cet amalgame, le produit est du vif-argent. Comme il n'y a aucune des molécules de ce produit qui ne ren-

ferme quelque portion d'exhalaison, ce corps a une qualité sèche dont les effets sont sensibles : il ne s'attache pas à la main ; au contraire, il fuit le contact : comme la chaleur a été le principe de sa coagulation, la chaleur ne peut la détruire. Si les deux principes [les vapeurs et les exhalaisons] se combinent dans des proportions à-peu-près égales, il se manifeste dans le mélange une humidité d'une nature visqueuse et onctueuse : à l'instant de la fermentation des particules aériennes s'insinuant dans le mélange qui se coagule alors par le froid, les produits de cet amalgame sont inflammables. Si les exhalaisons et la qualité onctueuse dominent, le produit est du soufre, qui est rouge, jaune, bleu ou blanc ; s'il y a plus d'exhalaisons et peu de principe onctueux, l'amalgame donne l'arsenic qui est rouge et jaune ; enfin si ce sont les vapeurs qui dominent, il se trouve, quand la coagulation est achevée, que le produit est de la naphte qui est noire et blanche. Comme, dans ces amalgames, la coagulation est produite par le froid, ces corps sont fusibles par la chaleur : et à cause de l'abondance de leur qualité huileuse et de leur humidité visqueuse, ils sont susceptibles de prendre feu ; enfin, à raison de leur excés d'humidité, ils ne sont point malléables. Les sept corps [ou metaux] ayant

tous pour principes constituans le vif-argent et le soufre, la variété de ces corps ne peut avoir pour cause que les divers degrés de pureté de ces deux principes, la plus ou moins grande perfection de leur mélange, et la diversité d'influence qu'ils exercent l'un sur l'autre.

"Si les deux principes ne sont altérés par aucun mélange de parties terreuses, s'ils sont dans toute leur pureté naturelle, si enfin ils éprouvent une coction parfaite, alors le soufre étant blanc et le vif-argent dans une proportion plus grande, le produit de l'amalgame est de l'argent ; il est de l'or, si les deux principes sont dans des proportions egales, et que le soufre soit rouge et possède la force colorante. Si, les circonstances étant les mêmes, après le mélange mais avant la parfaite coction, l'amalgame est coagulé par le froid, il se forme du *khar-tchini*, que l'on nomme aussi *fer de la Chine*, ce qui équivaut pour le sens à de l'*or cru* : quelques-uns le regardent comme une sorte de cuivre." (La même doctrine sur la formation du *khar-tchini* ou *âhen-tchini*, nommé encore *or cru*, se trouve dans cet ouvrage, fol. 60 *récto*, lig. I re et suiv). "Si le soufre seul n'est pas pur, que le vif-argent domine, et que la force brûlante unisse les deux principes, le produit est du cuivre. Quand

le mélange n'est pas fait convenablement, et que la proportion du vif-argent est la plus forte, il se forme de l'étain: quelques-uns prétendent que l'étain ne se forme pas à moins que les deux principes ne soient l'un et l'autre dans un état de pureté. Si les deux principes sont mauvais et tres-altérés, qu'il y ait dans le vif-argent des molécules terreuses interposées, et dans le soufre une qualité brûlante, il résulte, de l'amalgame, du fer: enfin le produit est du plomb, si, les circonstances étant d'ailleurs les mêmes, le mélange ne se fait pas complétement, et que le vif-argent domine. On donne à ces sept substances le nom de *corps*; on appelle le vif-argent *la mère des corps*, et le soufre *leur père*: on considère aussi le vif-argent comme l'*esprit*, et l'arsenic ainsi que le soufre, comme l'*ame*. Le *djost*, suivant quelques personnes, est l'*esprit de tutie*, et approche du plomb: il n'en est fait aucune mention dans les livres de philosophie. Il y en a une mine dans l'Indoustan, dans le territoire de Djalour, qui fait partie du soubah d'Adjmir.

"Les alchimistes disent que l'étain est un argent malade de la lèpre, le mercure un argent frappé de paralysie, le plomb un or lépreux et brûlé, et le cuivre un or cru, et que l'alchimiste, semblable à un médecin, remédie à ces maux par des

moyens contraires ou assimilés.

"Les savans qui s'adonnent à la pratique des arts, font, avec ces sept corps, des compositions artificielles dont on se sert pour fabriquer des bijoux, joyaux, &c. Du nombre de ces compositions est le *séfid-rou* [c'est-à-dire, *blanc à l'extérieur*, peut-être le *pé-tong* des Chinois], nommé *cansi* [1] par les Indiens, qui se compose de quatre sères de cuivre et d'un sère d'étain unis par la fusion: le *rouï*, composé de quatre sères de cuivre et d'un sère et demi de plomb, et que l'on appelle dans l'Inde *bahngar*: le *biroundj*, nommé par les Indiens *petel* [2] et dont il y a trois variétés; la première, qui se bat à froid, et contient deux sères et demi de cuivre, et un sère d'esprit de tutie: la seconde, qui se bat à chaud, composée de deux sères de cuivre et d'un sère et demi d'esprit de tutie: la troisième, qui ne se bat point, mais qui s'emploie pour les ouvrages jetés en moule et dans laquelle il entre deux sères de cuivre, et un sère d'esprit de tutie: le *sim-sakhtèh* [*argent marqué* ou *pesé*; peut-être faut-il lire *soukhtèh*, brûlé]," dans la

(1) Kámsya, See p. 114.

(2) Pittala, See p. 114.

composition duquel il entre de l'argent, du plomb et du cuivre, dont la couleur est d'un noir éclatant, et qui s'emploie dans la peinture : le *heft-djousch* [*bouilli sept fois*], dans lequel on se contente d'amalgamer six métaux, lorsqu'on n'a pas de *khar-tchini;* quelques-uns lui donnent le nom de *talikoun* [catholicon] ; mais suivant d'autres, le talikoun est un cuivre préparé : l'*escht-dhat*, composé de huit choses, savoir, les six métaux susdits, l'esprit de tutie et le *cansi ;* on le fait aussi avec sept substances seulement : le *caulpatr* composé de deux sères de *séfid-rou,* et d'un sère de cuivre ; il prend une couleur foncée très-agréable. C'est une des inventions de notre saint empereur." [1]

On the Essence of Minerals

Calamine

It will be seen Gladwin's rendering of Ain-i-Akbari is not very reliable ; it may, however, be noted here that even Blochmann in his much improved and more accurate translation erroneously

(1) "Chrestomathie Arabe," T. III. pp. 453-58 ed. 1827.

renders *jost* as "pewter."[1] The *rúh i tútia* (spirits of tutia) is used in the above extract in the same sense as in Rasārnava, which describes zinc as the *svattam* (essence) of *rasaka* (see p. 71). In R. R. S. also we find that blue vitriol yields a "*svattam*," which is no other than copper"[2] (p. 86).

The Vitriols

From the writings of Dioscorides and Pliny it does not appear that the ancient Greeks and Romans drew any sharp distinction between blue

(1) Vol. I. p. 40.

(2) The "essence or spirits of minerals" is used here in a different sense from that of the generality of the Arabian and European alchemists. According to the latter there are four spirits of minerals, namely, sulphur, arsenic, sal-ammoniac and mercury. "Les mots *esprits, corps, ames,* sont fréquemment employés par les alchimistes dans un sens spécial, qu'il importe de connaître pour l'intelligence de leurs écrits. Les passages suivants, quoique d'une époque plus moderne, jettent beaucoup de lumière sur ce point."

"On lit dans le traité *de Mineralibus*, prétendu d'Albert le Grand (L. I. tr. I, ch. I er): 'ce qui s'évapore au feu est esprit, âme, accident; ce qui ne s'évapore pas, corps et substance.'—"Coll. des Alch. Grecs," I. pp. 247-8. Cf. "Le cuivre est comme l'homme; il a corps et âme."—Introd. a la Chimie des Anciens, p. 294. See also, "La chimie au moyen âge," T. I. p. 73. and *ibid*. T. III. pp. 168-70; also *ante* p. 91.

and green vitriol respectively. The word *chalcanthum* was applied now to the one, now to the other.[1] In the Hindu Materia Medica no such confusion occurs. Even in the Charaka and the Susruta tuttham (blue vitriol) and kâsisa (green vitriol) are mentioned side by side.

BLUE VITRIOL

The word tuttham is generally applied to blue vitriol; in Rasendrasâramgraha and Sârngadhara, the following synonyms are given: तुत्थकं तु शिखिग्रीवं हेमसारं मयूरकं ।

R. R. S. uses mayûratuttham (मयूरतुत्थं) in Bk. ii. 129, which is a combination of the last and the first names in the above *sloka* Sikhigrîvam (lit.

(1) "Ich habe schon bei der Geschichte des Eisenvitriols darauf aufmerksam gemacht, welche Unsicherheit in den früheren Mittheilungen über Vitriol im Allgemeinen herrscht. Auch die älteren Angaben, welche am passendsten auf den Kupfervitriol bezogen werden, können zum theil auf Eisenvitriol gegangen sein." "Ges. der Chem." IV. p. 168.

"Observons les sens divers de ce mot couperose [chalcanthon], ou de son équivalent vitriol, tels que: vitriol bleu: sulfate de cuivre; vitriol vert: sulfate de fer, et sulfate de cuivre basique; vitriol jaune te rouge: sulfates de fer basiques." "Coll. d. Grecs." I. pp. 241-242.

resembling the neck of the peacock) is practically the same as "mayūrakantha sachchhāya*m*" in *s*loka, 127, *i.e.* having the play of colour in the throat of the peacock.

The term *s*asyaka as a synonym for blue vitriol does not ocur in any other medico-chemical work that I have come across except Rasār*n*ava.

That an essence in the shape of copper is yielded by blue vitriol is worthy of note from a historical point of view. Rasār*n*ava very often hits upon it but is not so explicit as R. R. S., as it modestly contents itself with the mere assertion that the essence is of the colour of *Coccinella* insect *i.e.* red (see p. 86). In the Bhāvaprakā*s*a (ca. 1550 A.D.) occurs this remarkable passage :[1] "तुत्थं तु ताम्रोपधातुर्हि किञ्चित्ताम्रेण तद्भवेत्" *blue vitriol is indeed a semimetal of copper as it is derived from copper.* The nomenclature itself is in wonderful agreement with that adopted nearly two centuries later by Boerhave[1] (1732 A. D).

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(1) "Die krystallisirten Verbindungen eines Metalls mit Säuren erkannte er nicht unbedingt als Salze an; die Vitriole namentlich rechnete er zu den Halbmetallen." Kopp: "Ges. d. Chem. III. p. 6.

Our knowledge of the nature of the "essence" of blue vitriol has thus been gradually advanced from Rasār*n*ava downwards.[1]

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(1) "Basil Valentine" seems to have known that some vitriols contained copper, but his "blue vitriol" does not necessarily mean sulphate of copper. "Der blaue Vitriol..........heisst bei Basilius vitriolum commune: was bei ihm Vitriolum Veneris gennant wird, ist oft Grünspan, und überhaupt geht diese Bezeichnung bei ältern schriftstellern auf sehr verschiedenartige Kupfersalze, wie denn Libavius in seiner Alchymia (1595) für die Bereitung des vitrioli Veneris vorschreibt............" Even Agricola (1494-1555), contemporary of Bháva does not make any great distinction between green and blue vitriol. "Agricola beschreibt in seiner Schrift de *re metallica* die Darstellung des Kupfrevitriols bei der des Eisenvitriols und des Alauns, ohne die beiden ersteren als wesentlich verschieden anzusehn, und auch in seiner Abhandlung "de natura fossilium" unterscheidet er nur verschieden gefärbte, nicht aber wesentlich verschiedne Vitriole"............" Ges. d. Chem." IV 170-171.

"Take five *palas* of saltpetre, one *pala* of sulphur and one *pala* of charcoal, prepared from the wood of *Calotropis gigantea* and *Euphorbia neriifolia* by destructive distillation[1]; powder them and mix them intimately and macerate them in the juice of the above-named plants and of garlic and afterwards dry the mixture in the sun and pulverise it to the fineness of sugar. Gunpowder (lit. fire-powder) is thus obtained. 201-202

"If the fire-powder is to be used for a gun, six or four *palas* of saltpetre are to be taken, the proportion of charcoal and sulphur remaining the same as before. 203

"For a gun with a light barrel, balls of iron or of other metals are to be used. 204

"The gun made of iron or of other metals are to be constantly kept clean and bright by the skilful artillerymen. 205

By varying the proportions of the ingredients, *viz.*, charcoal, sulphur, saltpetre, realgar, orpiment, calx of lead, asafœtida, iron powder, camphor, lac, indigo and the resin of *Shorea robusta*, different

(2) अन्तर्धूमविपक्व: lit., (wood) charred by smoke circulating through it.

kinds of fires are devised by the pyrotechnists giving forth flashes of starlight." 206-208

From the circumstantial details given above, especially of the method of preparing the charcoal, one is naturally led to suspect that the lines relating to gunpowder as quoted above are later interpolations. The suspicion is further enhanced when it is borne in mind that in the Polity of Kāmandakī, an ancient work of undoubted authenticity, there occurs no reference whatever to firearms nor is there any in the Agnipurā*n*a in which the subject of training in the use of arms and armours takes up four chapters, archery forming the leading element. [1]

The more rationtal conclusion would be that the *S*ukranīti is a patch work in which portions of chapter IV were added some time after the introduction of gunpowder in Indian warfare during the Moslem period.[2] Dr. G. Oppert, however, stands up for its antiquity.

In Halhed's "Code of Gentoo Laws," there is a passage which is sometimes quoted as a proof that

(1) See Intro. to Dr. R. L. Mitra's edition of Agnipurāna.

(2) Dr. R. L. Mitra, judging from the description of guns alone, concludes this portion to be spurious;—*vide* Notices of Sanskrit Mss. Vol. V. p. 135.

M. Berthelot's concluding remarks on Marcus Græcus' "Book of Fire" are equally applicable to *Sukraniti* :—

the ancient Hindus knew the use of firearms. Halhed, not having an acquaintance with Sanskrit, had to depend on the Persian translation of the Sanskrit digest prepared by some learned pundits. We have been at some pains in finding out the original text which is generally credited to Manu. It is only by a forced interpretation that anything in Manu may be taken to refer to a projectile discharged from a gun.[1]

"Mais je n'insiste pas, si ce n'est pour rappeler comment ces additions manifestent le caractère véritable de la composition de ces manuscrit et livres de recettes, déjà répandus dans l'antiquité et dont lis formules sont venues jusqu au XVIIIe siècle, parfois même jusqu'à notre temps. Le *Liber ignium* en est un exemple, et l'analyse précédente montre bien comme il a été composé avec des matériaux de dates multiples, les uns remontant à l'antiquité, les autres ajoutés à diverses époques, dont les dernières étaient contemporaines, ou très voisines de celle de la transcription de chaque manuscrit." "La Chimie au moyen âge" T. 1.135.

(1) The passage in Manu runs thus:

न कूटैरायुधैर्हन्याद् युध्यमानो रणे रिपून्।
न कर्णिभिर्नापि दिग्धैर्नाग्निज्वलिततेजनैः॥ मनु, VII. 90

We give below the commentaries of Medhâtithi and Kullûka Bhatta:—

In Sanskrit literature, there are frequent but vague references to 'agni astra" or firearms, but we have no reason to suppose that the combustible matter these fire arms contained supplied a motive power of the nature of gunpowder. The fire missiles were probably of the same category as the

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कूटानि यानि बहिःकाष्ठमयानि अन्तर्निशितशस्त्राणि । कर्णिनः शराः, ये शल्यस्य मूले मध्ये वा कण्टकाकारैः क्रियन्ते । ते हि प्रविष्टा दुरुद्धरा भवन्ति, प्रहारैरभिन्नमपि शरीरं प्रदेशं भिन्दन्ति । दिग्धाविषोपलिप्ताः । अग्निना ज्वलितमादीपितं तेजोमयफलकं येषां, एतैर्नयोद्धव्यम् । इति मेधातिथिः ।

कूटान्यायुधानि बहिः काष्ठादिमयानि, अन्तर्गूढनिशितशस्त्राणि तैः समरे युध्यमानः शत्रून् न हन्यात् ; नापि कण्टकाकारफलकैर्नापि विषाक्तैर्नाप्यग्निप्रदीप्तफलकैरित्यर्थः । इति कुल्लूकभट्टः ।

The correct rendering should be as follows:—"The king sha not slay his enemies in warfare with deceitful or barbed or poisoned weapons, nor with any having a blade *made red hot by fire* or tipped with burning materials"; Bühler, who also follows the above commentators, thus translates: "when he (the king) fights with his foes in battle, let him not strike with weapons concealed (in wood), nor with (such as are) barbed, poisoned, or the points of which are blazing with fire." Whereas Halhed's version is: "the magistrate shall not make war with any deceitful machine or with poisoned weapons or with cannon and guns or with any other kind of firearms."

"Greek fire," *i.e.* arrows or darts tipped with oiled flax, resin, regalar, naptha or other bituminous substances discharged from bows; sometimes elaborate machines being devised to hurl the weapons with more deadly effect. In the Udyogaparava of the Mahâbhârata, Yudhisthira is described as "collecting large quantities of resin, tow, and other inflammable articles for his great fratricidal war." [1] But there is nothing to show that gunpowder of any sort was in use or any chemical which would act as a propelling agent. [2]

The mention of gunpowder and of some sort of explosives with identical formularies occurs almost simultaneously in the Latin redaction of the work on

(1) See Dr. Mitra's "Antiquities of Orissa," 1.121.

(2) In the 11th century, Kâsmîr remained safe behind its mountain ramparts and was hermetically sealed to all foreigners with out exception. Here, according to Albîrûni, Hindu sciences retired and took shelter when the Mohammedan invasion of India began. But in the indigenous mode of warfare no reference to gunpowder is to be found; thus we read in Kalhana's Rajataraṅgini that in 1090 A. D. "he (Kandarpa) threw into the mêlée burning arrows smeared over with vegetable oil, struck by which the enemies caught fire. Believing that he knew [the use of] the weapon of fire *(agneya astra)*, they became frightened and fled in bewilderment, cursing their return."

Stein's Trans. Vol. 1. p. 344.

"Fire" by Marcus Græcus and in the writings of Roger Bacon about the 13th century.[1] Greek fire was introduced into Constantinople from the East abuot the year 673 and the Byzantians evidently knew that saltpetre was its basis; but they kept this knowledge strictly a secret, and abstained from speaking of it by any distinct name lest the information might leak out. Thus the very word saltpetre

The original passage is

तत्स्थानद नाराचान् निचिक्षेप स संयुगे ।
शिलानीषधितैलेन सिक्ता ये: प्राज्वलन् दिव: ॥
आग्नेयं तैलसाधनमिति मूर्खा विप्रक्षिता: ।
ते दूरं प्रयुञ्जीता भिन्दन्त: पुन रागमम ।
VII. 983, 989.

For further references to similar fire-missiles see Mahánáṭaka or Hanumána Náṭaka in Wilson's "Hindu Theatre," Vol. II. ed. 1835, appendix, pp. 369-70.

The first record of the use of cannon and gunpowder in Indian warfare is in the memoirs of Baber. In 1528 he forced the passage of the Ganges near Kanauj with the aid of artillery. For much valuable information on the subject of the early Asiatic fire-weapons the reader may consult an exhaustive article by Maj. Gen. R. Maclagan in the "Journ. As. Soc., Bengal," Vol. XLV. pp. 30 ff.

(1) "La Chimie au moyen" âge, I. p. 94.

is conspicuous by its absence in the literature of the ancients. Niturm (natron) was all along exclusively applied to carbonate of soda.[1]

SALTPETRE.

It will thus be seen that there is much in common in the history of the word used for nitrate of potash both in the Sanskrit and in the Latin languages, as in theformer "sauvarchala" and "yavakshāra" are indiscriminately applied to it.

It is very remarkable that in the later Sanskrit chemico-medical literature the very word sauvarchala, which stands for saltpetre in the *S*ukranīti and in the Rasār*n*ava, ceases altogether to be applied to it, but is used as a synonym of sārjikā (natron), while yavakshāra has been pressed into service,it being clean forgotten that from the time of Charaka and Sus*r*uta this word has been used

(1) Cf. "C'est par erreur que la plupart des éditeurs des auteurs grecs ou latins traduisent ces mots par nitre ou salpêtre, substance presque inconnue dans l'antiquité, et que apparaît seulement à partir du VI e siècle à Constantinople, avec le feu grégeois dont elle était la base. Les anciens parlent aussi du nitrum factice, préparé avec es cendres de chêne, c'est-à-dire du carbonate de potasse."—" Intro la l'étude de la Chimie," p. 263.

in its radical sense, *viz.*, the *ashes of barley* (impure carbonate of potash, from yava, barley and kshāra, ashes). Both Wilson and Monier Williams in their Sanskrit-English Dictionaries, following no doubt the authority of modern writers, erroneously render yavakhāra as saltpetre as also does Colebrooke in his "Amarakosha". Roth and Böhtlingk in their Wörterbuch, however, correctly translate it as "Aetzkali, ous der Asche von Gerstenstroh." [1]

It is strange indeed that a substance which occurs extensively in Bengal and in upper India as an efflorescence on the soil should have been allowed to go without a definite name for several centuries.[2] Dutt says "nitre was unknown to the ancient Hindus. There is no recognised name for it in Sanskrit.[3] * * * Some recent Sanskrit

(1) In the chemistry of Bubacar, "le sel de cendres" is the equivalent of yavakshāra—" La Chimie au moyen âge," 1. 308.

(2) We purposely use the words "allowed to go without a definite name," for the term sauvarchala was all along vaguely used now for saltpetre, now for natron.

(3) He is in error on this point, as he had not consulted, or probably had no acquaintance with, the old literature on the subject. Prof. Macdonell very properly points out "the dangers of the *argumentum ex silentio* [as] furnished by the fact that salt, the most necessary of minerals, is never once mentioned in the *Rig-*

formulas for the preparation of mineral acids containing nitre mention this salt under the name of "soraka". This word, however, is not met with in any Sanskrit dictionary and is evidently sanskritized from the vernacular *sorā*, a term of foreign origin. The manufacture of nitre was therefore most probably introduced into India after the adoption of gunpowder as an implement of warfare." [1] Mat. Med. of the Hindus, pp. 89-90, ed. 1900.

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veda. And yet the northern Panjáb is the very part of India where it most abounds. It occurs in the salt range between the Indus and the Jhelum in such quantities that the Greek companions of Alexander according to Strabo, asserted the supply to be sufficient for the wants of the whole of India." It would be equally hazardous to rush to the conclusion that nitre was "unknown" to the Hindus.

(1) Dutt is probably correct in so far as he states his views with regard to "the manufacture of nitre" as an ingredient of gunpowder. For it is well known saltpetre has been in use from time immemorial as the basis of rocket and other fireworks both in China and India. In the Dasakumáracharita by Dandí, mention is made of yogavartiká (magic wick) and yagachúrna (magic powder), of which saltpetre was probably the basis. The earliest account of the manufacture of saltpetre on a commercial scale that we have come across occurs in a rare work entitled: "The Travels of John Albert de Mandelso from Persia into the East Indies. London, 1669." The book is in the valuable collection of my friend, Mr. Prithvíra Chandra Ráya. Says our author :—

MINERAL ACIDS.

Geber was up till recently credited with being the discoverer of nitric acid, aqua regia, silver nitrate &c. A careful examination of the works of Geber, both real and pretended, notably of the celebrated *Summa perfectionis magisterii*, has convinced M. Berthelot that the knowledge of the mineral acids was unknown not only to the Arabs but also to the European alchemists of the thirteenth century. It was a Latin author of the latter half of the 13th century who wrote the above memorable work and assumed the

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"Most of the *saltpeter* which is sold in *Guzuratta* comes from *Ajmer*, sixty Leagues from Agra, and they get it out of Land that hath lain long fallow. The blackest and fattest ground yields most of it, though other Lands afford some, and it is made thus: they make certain trenches which they fill with their Saltpetrous Earth, and let into them small Rivulets, as much water as will serve for its soaking, which may be the more effectually done, they make use of their feet, treading it till it becomes a Broath. When the Water hath drawn out all the salt-peter which was in the Earth, they take the clearest part of it, and dispose it into another Trench, where it grows thick, and then they boil it like salt, continually scumming it, and then they put it into earthen pots, wherein the remainder of the Dregs goes to the bottom; and when the water begins to thicken, they take it out of these pots, to set it a-drying in the sun, where it grows hard, and is reduced into that form wherein it is brought into *Europe*." pp. *66-67*.

venerable name of Geber to gain public confidence.[1] Such instances of literary forgery are by no means uncommon in the alchemical literature of the East and the West.

The distillation of alum is referred to in Rasār*n*ava and of green vitriol in R.R.S. (see pp. 71, 92) We have, however, no evidence that the acid thus derived was ever used as a solvent. Hoefer justly remarks that real progress in chemistry was impossible in India and China, as the preparation of mineral acids was unknown in both these countries.[2] At the same time we should remember that Rasār*n*ava and similar other works lay stress upon vi*d*a, in which aqua regia may be said to be potentially present and which is fitly described as capable of "killing all the metals" (see p. 72)

The preparation of mineral acids is incidentally described in several exclusively medical works, composed probably in the 16th and 17th centuries, *e. g.* "Rasakaumudī" by Mādhava, Rasaratnapradīpa, and "Bhaishajyaratnāvalī" by Govindadāsa, &c. In

(1) "L'hypothèse la plus vraisemblable à mes yeux, c'est qu'un auteur latin, resté inconnu, a écrit ce livre dans la seconde moitié du XIIIe. siècle, et l'a mis sous le patronage du nom vénéré de Géber." "La Chimie au moyen âge," 1. 349.

(2) "Hist. de la Chimie," T. I. p. 25. ed. 1866.

the last work under the heading of mahādrāvakarasa, directions are given for distilling a mixture of, among other things, alum, green vitriol, salammoniac saltpetre and borax in a glass retort. In this way a dilute solution of nitro-muriatic acid is obtained, which is prescribed in derangement of liver and spleen. We have a similar recipe in which in addition to the above ingredients, rock-salt and sea-salt are used, thus yielding what is called "sa*m*khadrāvaka" (lit. solvent for conch-shell.)

The term "drāvaka" (solvent) seems to have been expressly coined to do duty for the mineral acids. We have seen all along that in the older works drāvaka was used invariably in the sense of solvent or flux (see p. 130) but never in the sense of a mineral acid, the knowledge of which seems to have spread both in the East and the West almost simultaneously. The regular application of the mineral acids to technical operations dates from the time of the Emperor Akbar or perhaps a little earlier. Thus in the *A'in-i-A'kbari* under the "Method of Refining Silver" mention is made of the use of *rasi* (aqua fortis). It is not easy to make out how much of the processes of the assay of gold and silver as described in the *A'in* is of Hindu origin.

Royle, Sir W. O'Shaughnessy ("Manual of

Chemistry"), Ainslie and others maintained that the Hindus were acquainted with the methods of preparing the mineral acids. These authors who wrote more than half-a-century ago derived their information at second-hand as none of them had probably read the Sankrit works in the original. Ainslie gives the following recipes as used in Southern India among the Tamil physicians for the preparation of sulphuric, nitric and muriatic acids respectively:

Sulphuric acid: "The Tamil physicians prepared their article nearly in the same way that we do, *viz.*, by burning sulphur with a small with a small piece of nitre in strong earthen vessels."

O'Shaughnessy says: "sulphuric acid, the *Gundak ká áttar* of the Hindus has long been known among the Eastern nations. In southern India it has been prepared for many centuries."

Nitric acid: This acid the Hindus make a clumsy attempt at preparing in the following manner which must not be rigidly criticised by the chemists of Europe.

Take of saltpetre	20 parts.
,, alum	16 ,,
,, the acid liquid from the leaves and stem of the Bengal horsegram	18 ,,

Mix and distil with an increasing heat till the whole of the acid is condensed in a receiver.

Muriatic acid : 'Take of

common salt	,,	8 parts
alum	,,	6 parts

The acid liquid from the horse gram and distil &c."

The very name of sulphuric acid, *Gundak kā āttar* is Urdu *i.e.* the hybird *lingua franca*, an admixture of Hindi with Persian. *Attar* in Persian means the volatile princinple, often odoriferous, *e.g. Gulāb kā āttar i.e.* otto de Rose. "Gundhak" in Sanskrit is the equivalent for sulphur.

Knowledge of Technical Arts

AND

Decline of Scientific Spirit

In ancient India the useful arts and sciences, as distinguished from mere handicrafts, were cultivated by the higher classes. In the White Yajur-Veda and in the Taittirīya Brāhmaṇa, we meet with the names of various professions which throw light on the state of society of that period ; unfortunately a knowledge of these perished with the institution of the caste system in its most rigid form. [1] Among the sixty-four "kalās" or arts and sciences which are enumerated in the old work of Vātsāyana [2] called Kāmasūtra occur the names of the following :

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(1) See Dutt's "Civilization in Ancient India," pp. 155-157, Calcutta ed.

(2) "Vátsáyana is another old authority...............The name occurs in Páṇini 4. 1. 73. and probably the author of the Kámasutras was meant as some of his rules refer to terms chiefly used in the latter. The text has come down to us almost undefiled, showing its great popularity among our ancestors, which is also clear from its commentaries and reference by Dandí, Vámana and other great writers."—Preface to Barua's "Amarakosha," preface, xiii.

सुवर्णरत्नपरीक्षा :—or the examination and valuation of gold and gems.

धातुवादः or chemistry and metallurgy.

मणिरागाकरज्ञानम् : :—or knowledge of the colouring of gems and jewels, as also of mines and quarries.

In the Sukranītisāra or the Elements of Polity by *S*ukrāchārya, we also read an account of the various "kalās" : *e.g.*

पाषाणधात्वादिदृतिस्तद्भस्मीकरणं कला :—" the art of piercing and incinerating the stones and the metals is known as a "kalā."

धात्वौषधीनां संयोगक्रियाज्ञानं कला स्मृता : :—"a knowledge of the combinations of the metals and the herbs and the plants is also regarded as a "kalā."

धातुसाङ्कर्यपार्थक्यकरणन्तु कला स्मृता ।
संयोगापूर्वविज्ञानं धात्वादीनां कला स्मृता ॥

" The art of alloying and separating the metals is also known as a "kalā."

क्षारनिष्कासनज्ञानं कलासंज्ञन्तु तत् स्मृतम् ।
कलादशकमेतद्धि ह्यायुर्वेदागमेषु च ॥

" The art of extracting alkali (see pp. 31-38 under Susruta) is likewise counted as a "kalā". In the science of Āyurveda, there are altogether ten "kalās"

We also find that among the companions of the poet Vāṇa were an assayer and a metallurgist.[1] Such terms as "lohavid" and "dhātuvid" which occur repeatedly in Sanskrit literature show that the metallurgists were held in high esteem and expert knowledge sought after.

The art of dyeing was carried almost to perfection, the fast colours resembling the Tyrean purple.

In the Vedic age the *Ri*shis or priests did not form an exclusive caste of their own but followed different professions according to their convenience or natural tastes, thus fulfilling the ideal laid down by Emerson : "Has he (man) not a *calling* in his character? Each man has his own vocation. The talent is the call." But all this was changed when the Brāhmins reāsserted their supremacy on the decline or the expulsion of Buddhism.

The caste system was established *de novo* in a more rigid form. The drift of Manu and of the later Purāṇas is in the direction of glorifying the priestly class, which set up most arrogant and outrageous pretensions. According to Susruta, the dissection of dead bodies is a *sine quâ non* to the student of surgery and this high authority lays par-

(1) Cowell and Thoma's Trans. of Harsha-charita, p. 33.

cular stress on knowledge gained from experiment and observation.[1] But Manu would have none of it. The very touch of a corpse, according to Manu, is enough to bring contamination to the sacred person of Brāhmin.[2] Thus we find that shortly after the time of Vāgbhaṭa, the handling of a lancet was discouraged and Anatomy and Surgery fell into disuse and became to all intents and purposes lost sciences to the Hindus. It was considered equally undignified to sweat away at the forge like a Cyclops. Hence the cultivation of the *kalās* by the more refined classes of the society of which we get such vivid pictures in the ancient Sanskrit literature

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(1) त्वक्पर्यन्तस्य देहस्य योऽयमङ्गवि निश्चयः ।
शल्यज्ञानादृते नैष वर्ण्यतेऽङ्गेषु केषुचित् ॥
तस्मान्निःसंशयं ज्ञानं हर्त्रा शल्यस्य वाञ्छता ।
शोधयित्वा मृतं सम्यग् द्रष्टव्योऽङ्गविनिश्चयः ॥
प्रत्यक्षतो हि यद्दृष्टं शास्त्र दृष्टं च यद्भवेत् ।
समासतस्तदुभयं भूयो ज्ञानविवर्द्धनम् ॥ 43-45

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शरीरे चैव शास्त्रे च दृष्टार्थः स्याद्विशारदः ।
दृष्टश्रुताभ्यां सन्देहमवापोह्याचरेत् क्रियाः ॥ 48

Sārīra. Ch. V.

(2) The "Laws of Manu," V. 64,85,87.

has survived only in traditions since a very long time past.[1]

(1) Similar dangers have theartened Europe from time to time but her sturdy sons have proved better of them in the long run. Thus "Aristotle's opinion that 'industrial work tends to lower the the standard of thought' was certainly of influence here. In accordance with this dictum the educated Greeks held aloof from the observation and practice of technical chemical processes; a theoretical explanation of the reactions involved in these lay outside their circle of interest."—Meyer's "Hist. of Chemistry," trans. by McGowan, p. 10, ed. 1898.

Paracelsus flings a sneer at the physicians of his time and compares them with the alchemists in the following terms: "For they are not given to idleness nor go in a proud habit, or plush and velvet garments, often showing their rings upon their fingers or wearing swords with silver hilts by their sides, or fine and gay gloves upon their hands, but diligently follow their labours, sweating whole days and nights by their furnaces. They do not spend their time abroad for recreations but take delight in their laboratory. They wear leather garments with a pouch, and an apron wherewith they wipe their hands. They put their fingers amongst coals, into clay, and filth, not into gold rings. They are sooty and black like smiths and colliers, and do not pride themselves upon clean and beautiful faces."—Quoted by Rodwell in his "Birth of Chemistry."

Even so late as the middle of the last century, the pursuit of Chemistry in England was not regarded in a serious light and "chemists were ashamed to call themselves so because the apothecaries had appropriated the name"—a circumstance which led Liebig in 1837 to declare "that England was not the land of science."

The arts being thus relegated to the low castes and the professions made hereditary,a certain degree of fineness, delicacy and deftness in manipulation was no doubt secured but this was done at a terrible cost. The intellectual portion of the community being thus withdrawn from active participation in the arts, the *how and why* of phenomena—the coördination of cause and effect—were lost sight of—the spirit of enquiry gradually died out among a nation naturally prone to speculation and metaphysial subtleties and India for once bade adieu to experimental and inductive sciences.[1] Her soil was rendered morally unfit for the birth of a Boyle, a Des Cartes or a Newton and her very name was

(1) The Vadánta philosophy, as modified and expanded by Saṁkara, which teaches the unreality of the material world, is also to a large extent responsible for bringing the study of physcial science into disrepute. Saṁkara is unsparing in his strictures on Kaṇáda and his system. One or two extract from Saṁkara's Commentary on the Vedánta Sûtras, will make the point clear :

'तस्मादेवमसारतरतर्कसंदृब्धत्वात्, ईश्वरकारणश्रुतिविरुद्धत्वात्, श्रुतिप्रवणैश्च शिष्टैर्मन्वादिभिरपरिगृहीतत्वात्, अत्यन्तमेवाऽनपेक्षास्मिन् परमाणुकारणवादे कार्याऽऽर्यैः श्रेयोऽर्थिभिरिति वाक्यशेषः । २।२।१७ सूत्रभाष्यम् ।

वैशेषिकराद्धान्तो दुर्युक्तियोगाद् वेदविरोधात्, शिष्टापरिग्रहाच्च नापेक्षितव्य इत्युक्तं । सोऽर्धवैनाशिक इति वैनाशिकत्वसाम्यात् सर्ववैनाशिक-राद्धान्तो नितरामनपेक्षितव्य इतीदं इदानीं उपपादयामः । २।२।१८ सूत्रभाष्यम् ।
"Vedánta Darsana," Bombay ed.

all but expunged from the map of the scientific world.[1]

In this land of intellectual torpor and stagnation the artizan classes, left very much to themselves and guided solely by their mother wit and sound commonsense, which is their only heritage in this

"It thus appears that the atomic doctrine is supposed by very weak arguments only, is opposed to those scriptural passages which declare the Lord to be the general cause, and is not accepted by any of the authorities taking their stand on scripture, sush as Manu and others. Hence it is to be altogether disregarded by high-minded men who have a regard for their own spiritual welfare." II. 2, 17

"The reasons on account of which the doctrine of the Vaiseshikas cannot be accepted have been stated above. That doctrine may be called semi-destructive (or semi-nihilistic)." Thibaut's trans., *Ibid.* 18.

(1) Among a people ridden by caste and hide-bound by the authorities and injunctions of the Vedas, Purana*s*, and Smi*r*itis and having their intellect thus cramped and paralysed, no Boyle could arise to lay down such sound principles for guidance as :

P. XXVI." . . . I saw that several chymists had, by a laudable diligence obtian'd various productions, hit upon many more phenomena, considerable in their kind, than could well be expected from their narrow principles : but finding the generality of those addicted to chymistry, to have had scarce any view, but to the preparation of medicines, or to the improving of metals, I was tempted to consider the art, not as a physician or an alchymist, but a philosopher. And, with this view, I once drew up a scheme

world, have kept up the old traditions.[1] In their own way they display marvellous skill in damescening, making ornamental designs on metals, carving on ivory, enamelling, weaving, dyeing lace-making, goldsmith's and jeweller's works, etc.[2]

The successive stages in the manipulation of one branch of the arts have been carefully watched by Mr. Jñānasaraṇa Chakravartī M. A., late Scholar, Presidency College, and his experiences embodied in a paper, which, for the most part, is reproduced below with certain alterations; it is of singular interest as a contribution to the history of the Indian technical arts. It now remains only to add that some of the processes described below were in

for a chymical philosophy; which I shou'd be glad that any experiments or observations of mine might any way contribute to complete.'

P. XVIII. "... And, truly, if men were willing to regard the advancement of philosophy, more than their own reputations, it were easy to make them sensible, that one of the most considerable sevices they could do the world is, to set themselves diligently to make experiments, and collect observations, without attempting to establish theories upon them, before they have taken notice of all the phenomena that are to be solved." Shaw's ed. of Boyle's works, 3 vols. 1725.

(1) Vide manufacture of alum, pp. 147-51.

(2) For detailed information on some of these branches the reader may consult Birdwood's Industrial "Arts of India".

vogue at the time of the Emperor Akbar and probably existed long before, as Rasārṇava amply testifies (p. 68). The very terms "*poonoor*" (*punhār*) and "Neharwalla" (Niāriyah) occur in the descriptions of the assay of gold in Āin-i-Ākbari. [1]

The wastage of Gold in the course of Preparing Jewelry in Bengal [2]

Soldering

The next process that we shall consider is soldering. This is undoubtedly the most important process that the goldsmith has to perform from a commercial point of view. It is in the course of this process that the practical goldsmith plays those

(1) Along with Mr. Chakravarti's Essay should be read Āins 7, 8 and 9 "on the Manner of Refining Gold," "the Method of Refining Silver" "and the Method of Separating the Silver from the Gold," Blochamann's trans. Vol. I. pp. 20-25.

(2) "Indian Engineering." XIX (1896). The Mechanical Operations of Melting and Hammering have been left out.

mischievous tricks which go so hard against those who purchase his productions or order for them. The quality or quantity of solder (or *pân*) employed is the first question that is universally enquired into in all cases of commercial dealings in Indian jewelry; and while by melting some articles the value of the gold per tola is reduced by Re. 1 or 2 only, we frequently find cases in which the value is decreased at the ruinous rate of Rs. 8 or Rs. 10. This last state of affairs arises when the solder consists almost entirely of a mixture of baser metals and is at the same time fraudulently used in larger quantities than what is absolutely necessary.

Considered, however, from the standpoint of a chemical student who investigates the subject of ascertaining the amount of metal that is lost in the operations of the goldsmith, the process of soldering is scarcely important enough to receive a separate treatment. The preparation of the solder and its reduction to the condition of small thin bits are embraced in the discussion of melting and hammering; while the loss during the blowing operation, during which the reducing flame of an oil lamp is made to play upon the solder and the parts it is meant to join together, may be supposed

to have been treated during the discussion of the subject of loss of gold by volatilisation. The fact that almost all solders contain a little zinc perhaps makes the loss in their case to be much greater than in that of an alloy of gold and copper only. The following three sets of figures give the weight of gold and the weight of solder before the process of soldering and the weight of the article after the operation has been finished :—

Gold			Solder			Wt. of Gold & Solder after operation.		
Tolas	annas	pies.	Tolas	annas	pies.	Tolas	annas	peis
6	0	0	1	0	0	6	15	0
2	0	0	0	8	0	2	7	13/4
3	8	0	1	4	0	4	10	3

Thus, on the whole a loss of 11¼ pies takes place in dealing with 14¼ tolas of materials. This gives the rate of loss at 79 pies per tola.

It is proper to observe that of the loss that takes place during soldering, about one-third is due to purely physical causes, *e. g.* the loss of pieces of solder which fly off before the blowpipe. The above figures are accordingly not to be supposed as affording an accurate estimate of the amount of material that is lost by vapourisation during the operation of soldering.

FILING AND CUTTING

These are the two operations of the goldsmith in the course of which gold is lost to an appreciable extent. The work of cutting is done by a class of men called *nakāshiwalās* to whom the articles are made over for the purpose. In recognition of the fact that loss of gold must inevitably take place during the operation of cutting, the goldsmith, when he takes back the articles and the particles that are chopped off the surface from the *nakāshiwalās*, generally makes an allowance of one pie per tola in favour of the latter.

The loss which takes place during the operation of cutting as well as the loss during filing, *i.e.* rubbing the surface of gold with a steel file to make it smooth, is due to causes of a purely mechanical nature and can be prevented to a great extent by the means suggested for minimising such loss in the course of hammering and drawing.

The operation of cutting is always, and that of filing some times, effected after the article has been coloured and polished. But as the chemical process of colouring will be treated of separately in the following pages, the mere mechanical operation

of cutting and filing are here put in for the purpose of preserving continuity.

THE CHEMICAL OPERATIONS OF THE GOLDSMITH: CLEANSING, COLOURING AND POLISHING

We now come to a process which, though not so important in the eyes of the goldsmith as some of the processes before described, is yet of the greatest consequence in the enquiry in which we are engaged. This is the process of colouring.

If it were possible for our goldsmiths to work with pure gold, the appearance of the material would suffer very little by the various processes of heating, hammering, &c., and a mere mechanical rubbing would throw off the superficial dirt and be sufficient to expose the natural yellow surface of the unalloyed metal. This property of pure gold is due to the fact that no oxides of gold are formed at temperatures to which the metal is exposed during the operations of the goldsmith. Indeed it is well-known thst gold does not unite with oxygen at any temperature.

But the case is different with copper, the oxide of which is formed at temperatures which are ordinarily attained by the goldsmith in the course of his operations. Hence, if a mass of copper is

heated in the goldsmith's fire, it is divested of its bright red colour and acquires a dirty black appearance due to the formation of a coating of cupric oxide. Now, an alloy is nothing but an intimate mechanical mixture of its constituent metals—the molecules of the several metals lying promiscuosly as it were. In an alloy of gold accordingly in which copper forms a constituent part, the particles of the latter are freely interspersed between those of gold. When such a substance is heated in air, the gold particles retain their primitive yellow, but the particles of copper, which are exposed to air, are oxidised into CuO. This substance is, as we know, a black amorphous powder and it gives to the whole mass a black appearance, which becomes darker as the metal is hammered over and the powder is thoroughly spread over the surface of the metal.

An interesting and rather curious experiment clearly illustrates the above explanation. If a piece of gold containing a little copper be heated in air and care be taken not to rub the metal in any way so as to spread the black oxide of copper over the surface, it will be found that the metal, if free from external dirt or soot, will be still yellow and tolerably bright. The yellow of the more numerous gold particles overpowers the colour of the black

oxide of copper. If, however, this black substance be spread over the surface of the metal, the colour instantly changes. The spreading of the oxide is easily brought about by hammering, and thus we can take an apparently bright piece of metal and, by hammering reduce it to a jet black mass.

The ignorant goldsmiths explain this blackening by supposing the stain of the black steel hammer to adhere to the surface of gold.

We may, perhaps, in this connection mention a particular artifice which is sometimes employed by our goldsmiths to cleanse the surface of a gold and copper alloy, which has been blackened by fire. This method is employed whenever it is desirable in the course of working to expose the bright surface, but where it would be inconvenient, impossible or unnecessary to apply the long and laborious mode of cleansing or colouring which we shall hereafter describe, It is found that if a blackened piece of gold and copper alloy be heated in a charcoal fire to redness and then water be sprinkled on the fire, the alloy at once acquires the bright colour of gold. This phenomenon, though often practised by our goldsmiths, is a puzzle to the most intelligent among them. * * * * * The true explanation of the operation seems to be

that, when placed in a charcoal fire, the cupric oxide is reduced to metallic copper. But if it is taken out when hot, it comes into contact with the air again and is oxidised. What the goldsmith does is to suddenly cool down the metal when in the reduced state and not to allow it to come into contact with the open air, until it has cooled sufficiently down, so as not to be liable to re-oxidisation.

From what has been stated above, it will be easily seen that when a piece of golden ornament has been completed by the manufacturer, it is of a dirty dark colour and must be cleansed before it can be used. In this country mere cleansing is not sufficient, for the popular taste does not approve the new golden articles appearing and being used in the yellow colour of true gold. The articles must be "coloured" before they can be made over to the customer, by which is meant that a bright reddish colour must be imparted to them. The particular tinge which is liked by different persons is different, some people liking a colour verging very nearly on red or orange, while others have a fancy for a colour whfch approaches to reddish violet.

The process of imparting the requisite shade of colour to articles of gold is one of the most

cumbrous and complicated chemical operations in the whole range of indigenous arts and manufactures of India. The numerous chemical reactions that take place in the several stages of the business are of more than ordinary interest; while the immense loss of gold that apparently takes place leads one to wonder why the subject has not as yet been taken up seriously by commercial or scientific men.

The process of colouring, so recently as 20 years ago, was universally carried out by the goldsmiths themselves, and in the villages and smaller towns the state of afairs is still the same. But in the metropolis and at the bigger stations of the province, the advantages of the principle of division of labour have lately begun to be felt in every branch of art and manufacture, and the result, so far as this particular subject is concerned, has been the springing up of a class of people whose sole business is to colour ornaments and other articles of gold. These men are known among our goldsmiths as the *rungwalas*. They do not charge any remuneration for their labour, but retain the fluid in which, during the process of colouring, a quantity of gold is dissolved.

We will now follow the *rungwala* through the course of a complete set of processes for colouring,

skipping over the mere mechanical parts of the work, but dealing a little fully with the portions which are of a chemical nature.

THE PROCESSES OF THE RUNGWALA

The shop of a Calcutta *rungwala* is one of the most miserably furnished working-places in the whole metropolis. A charcoal fire, a pair of bellows, a few crude pieces of indigenous earthern-ware, two or three coarse pots of China, together with a few other little things, are all that greet the eager sight of the observer whom business or curiosity leads to his dark and ill-ventilated den.

The *rungwala* has to wait till a suffiicient number of golden articles are accumulated in his hands. He does not generally commence the process until he has got at least ten tolas of gold for colouring. Because the cost, the trouble and the time required, as he says, in going through a complete series of operations are such as to prohibit his doing the work with a smaller amount of gold at a time. Ordinarily a "khola", as the amount of gold coloured at one operation is called, consists of about 20 to 30 tolas of gold.

Having got the amount of gold sufficient for working a *khola*, the first thing that the *rungwala*

has to do is to cleanse the articles of all external dirt as well as of the blackess due to the formation of CuO. With this view he first heats them in a charcoal fire, thus causing all the oil, charcoal dust, and other foreign substances on the surface to burn off. He next puts an earthen vessel on his fire and boils in it about a seer of the unripe fruit of tamarind (Tamarindus Indica), a sustance containing considerable amount of tartaric and other acids in the free state. Taking out these boiled articles and squeezing them so as to extract the extremely acid pulp he forms a thick syrupy fluid. In this fluid he boils the articles till the dilute acids dissolve away the cupric oxide, leaving a yellow surface of pure gold. It is found that the solution of tamarind pulp becomes distinctly blue in vitrue of the formation of copper salts.

In the place of this rather clumsy mode of cleansing, which is largely practised even in the metropolis, some of the more adventurous *rungwalas* use a rather more clever and neater method. Instead of preparing a large amount of tamarind pulp, they obtain from the grocer's an ounce or two of a dull white crystalline substance which they call "acid," and a solution of this serves equally well, if not better, for their purpose. To the question

as to what the substance called "acid is, they cannot give a satisfactory reply. And even the grocer who sells it cannot enlighten the inquirer more than to this extent that the article is a *gād* (scum) or a bye-product in the manufacture of some acid. Having subjected the substance to a rough chemical analysis, we came to to conclusion that the substance should be nothing more nor less than $KHSO_4$ or hydric potassic sulphate, an acid salt and a bye-product, as we know, in the process of manufacturing nitric acid. The reaction of this substance on the copper seems to be this :—



$$2\,KHSO_4 + CuO = K_2SO_4 + CuSO_4 + H_2O.$$

The normal salt di-potassic sulphate, copper sulphate and water are formed.

What takes place in the gold as regards the particles of copper takes place also in the solder used as regards the particles of both zinc and copper that are on the surface.

The oxides of copper and zinc are acted on by the dilute acids of the tamarind or the hydric potassic sulphate as the case may be, and are dissolved away in the form of soluble salts. The reaction in the latter case is:—



$$2\,KHSO_4 + ZnO = ZnSO_4 + K_2SO_4 + H_2O.$$

As the solder contains a large amount of silver,

its appearance after the copper and zinc have been dissolved away, is almost perfectly white, which appears rather prominent by the side of the bright yellow surface of gold.

The next operation of the *rungwala* is perhaps intended to carry on the operation of cleansing to a further extent. He takes about half a pound of common salt, and mixes it with an equal amount of ordinary potash alum, purchased from the bazar.

The mixture is then reduced to the form of a fine paste. The *rungwala* now covers each of the articles to be coloured with a thin layer of this paste of salt and alum and then places them on the fire. After the paste has dried up it is washed off with water, and generally the colour of the gold appears a little bit improved. The reason of this lies in the fact that the few particles of cupric oxide that remain on the surface are not wholly dissolved out by dilute acid in the first operation are got rid of by this process.

After having been subjected to these two processes, the article acquires almost perfectly the beautiful yellow of pure gold; but as has been stated already the *pān* or solder appears at the same time as white as pure silver. The contrast of these two different colours placed in close con-

tiguity is rather marked: and the next operation of the *rungwala* is intended to remedy this defect. In order to make the solder and the metal appear of the same colour, he actually covers the surface of the solder with a layer of gold taken from the article itself. This is done in the course of the third process, which we will describe rather fully, as it is the most important of these stages of manipulation at which loss of gold takes place in considerable amount.

Having placed an open earthen vessel on his fire and having put some water in it, the *rungwala* prepares a mixture consisting of about four parts of nitre (say 1 lb.), one part of common salt and 1 part of alum (say ¼ lb each).[1] He then puts the mixture into the vessel, taking care always that the water in the vessel be not more than what is necessary for dissolving about half the amount of salts added. The solution is then heated till it boils evolving large quantities of gases and fumes, amongst which chlorine can be easily detected by its unmistakable corroding odour.

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(1) Cf. p. 73 under "killing of mercury and gold," where a mixture, among other ingredients, of alum, common salt and saltpetre technically called a *vida*, is used.

In this boiling solution the goldsmith places the cleansed ornaments so as to keep them wholly immersed. He examines them from time to time and after a while finds that a layer of shining gold has formed on the surface of the white solder. When this deposit is sufficiently thick and the whole article presents the appearance of being formed out of a homogeneous material he takes them out and, washing them well, prepares them for the next operation.

Chemical Explanation

It is difficult to find out exactly the series of chemical reactions that take place during this period. Various impurities in the articles employed make the inquiry doubly complicated. It would, however, do for our purpose to investigate briefly the principal decompositions and formations that occur, and with this view we may suppose the reagents employed to be chemically free from foreign substances.

It is well-known that if nitric and hydrochloric acids are brought together, certain reactions take place. If the acids be tolerably concentrated they act upon one another at ordinary temperatures, the mixture becoming yellow and giving off minute

bubbles of gas, smelling like chlorine. If the acids be dilute, we have to heat the mixture to bring about the chemical change. The action that takes place consists of two of stages :—

First, the oxygen from the nitric acid oxidizes the hydrogen of the hydrochloric acid, thus :—



$$HNO_3 + 2HCl = H_2O + HNO_2 + Cl_2 \ldots \qquad \text{(i)}$$

Secondly, the unstable nitrous acid that is formed acts on another molecule of HCl, producing a compound known as nitrosyl chloride and water, thus :—



$$HNO_2 + HCl = NOCl + H_2O \ldots \qquad \text{(ii)}$$

The reactions (i) and (ii) when expressed by a single equation may be written as follows :—



$$NO_2OH + 3HCl = NOCl + 2H_2O + Cl_2 \qquad \text{(iii)}$$

Now, here, instead of free nitric and hydrochloric acids, we have saturated solutions of a nitrate and a chloride, and an action similar to the above may take place under the influence of heat only, instead of water, the hydrates of the metals present in the nitrate and the chloride are formed. Thus, instead of equation (iii) we may have the following action :—



$$NO_2.OK + 3NaCl + 2H_2O = NOCl + 3NaOH + KOH + Cl_2.$$

When the solution boils and these actions set

in, the *rungwala* puts the golden articles in it. The chlorine liberated as well as the chlorine in the nytrosyl chloride attacks the gold and reduces it to the form of a soluble chloride, which mixes with the mass of the fluid. The NO of the nitrosyl, which is liberated, is itself a colourless gas, but it rapidly unites with the oxygen of the air and forms the red fumes of nitrogen peroxide which, together with chlorine, are liberated in large quantities during the third stage of colouring.

Now we know that if a solution of gold chloride of sufficient strength is formed and a piece of silver is dipped into it, gold is deposited on the surface of the silver, while a portion of the silver is worn away. The reaction is as follows :—



$$AuCl_3 + 3Ag = 3AgCl + Au.$$

This reaction takes place in connection with the surface of the solder which is exposed. A layer of gold is formed upon it entirely hiding the white surface, so that to all appearance the whole article seems to be composed of the same material.

In the explanation given above, the use of alum that is added to make up the *jamak* (as the solution employed in the third stage described above is called) has not been shown, and indeed this point we have not been able to clear as satisfactorily as

perhaps it is capable of.[1] It seems to undergo no chemical change, and hence does not act in the capacity of a mordant in this case, as it does so widely in the arts of dyeing or calico printing. It is also found that if no alum is added to the *jamak*, the coating of gold on the solder is produced, but it adheres very lightly to the surface and does not stand such processes as rubbing or brushing. Hence it seems that the only function of the alum is to fix the coating, i.e. to make it adhere firmly to the surface of the solder. Experienced goldsmiths are also of opinion that, but for the alum, the gilding of the *pān* would not be permanent. The way in which this is done by the alum is to a certain extent a matter of conjecture. We suppose that the action is of a mere mechanical nature. When the particles of gold stick to the surface of the solder, small quantities of alum solution remain in the pores between the separate particles. These afterwards dry up and crystallise, and the minute crystals act as a sort of mortar

(1) Mr. Chakravarti all along fails to realise the important part which alum plays in yielding sulphuric acid. Moreover in the above equation chlorine cannot be expected to be set free in presence of alkalies; see below under "the Hindu method of manufacturing calomel."

between the particles of gold and the surface of the solder, as well as between the particles themselves.

The third process in the course of colouring is by far the most important source of loss of gold in the whole series of manipulations that the metal has to undergo. We have seen that the losses at all other stages are due to causes of a mere mechanical nature and are necessarily small. In all these cases, the gold escapes the vigilant eye of the worker and hence the extent to which it is lost sight of is minute indeed. Here for the first time the gold undergoes a chemical change—it ceases to exist as gold altogether—and is consequently lost for ever to the illiterate goldsmith.

We should remark that only a very small part of the gold that is dissolved out in the *jamak*—as the solution of nitre, alum and salt used in the third stage described above is called—is re-deposited on the surface of the solder. A large portion of the gold remains in the solution as $AuCl_3$, $NaCl$. $2H_2O$. The helpless *rungwala* can do nothing with his valuable fluid but dispose it off for a trifling sum to a class of men called *jamakwalas* who have a crude method of their own to extract some quantity of the gold from the *jamak*. We

shall return to the *jamakwala* subsequently. We must now proceed to the fourth or last stage of colouring, during which the requisite colour is imparted to the metal. The articles, after being extracted from the boiling *jamak* solution, are thoroughly washed and rubbed with a brush, after which another bath is prepared for them. This consists of a solution of tamarind pulp, nitre and common salt in water, which is placed in an earthen pot on fire and heated to ebullition. A little sulphur is then added after which the articles are placed in the liquid. The sulphur is added in a finely divided state, obtained by rubbing a stick of sulphur with a little water on a piece of slate. Care is always taken to add an insufficient amount of sulphur at first, for it is found that the shade of colour that is produced in the gold depends solely on the quantity of this ingredient, which accordingly requires exceedingly carefuly regulation. The *rungwala* now examines the colour from time to time, adding more sulphur gradually if he wants the colour to deepen. When the requisite shade of colour is reached, he stops adding the sulphur and keeps on boiling for some time more, after which he takes the articles off the solution and gives them a final wash and polish. If too much

sulphur is added in this operation the colour becomes deep violet and finally black, and the whole process is vitiated. Under the circumstances the *rungwala* has to recommence the work from the very beginning.

It may be noticed that the acid or the commercial hydric potassic sulphate is never used in this stage, as it is used in the first, instead of the tamarind pulp. The reason seems to be that as nitre is also present in the mixture, the addition of $KHSO_4$, in the presence of other substances, may result in the formation of nitric acid under the influence of heat.

The chemical actions that take place during the fourth or last stage of colouring seems to be extremely difficult of explanation. There can be little doubt, however, as to the fact that the reddish violet colour is due to the deposition of a thin layer of some compound of gold on the surface of the articles. It is the determination of this compound and of the exact nature of the process by which it is formed that presents all the difficulty.

The fact that the sulphur is one of the most essential things that are required in the production of the colour would seem strongly to suggest at the first glance that the reddish violet tint is due

to the formation of one of the sulphides of gold. It appears that the subject and constitution of the compounds of gold and sulphur is one which has not yet been fully investigated by chemists. But it seems to be a well-established fact that no sulphide of gold is known which is of any other colour than black. This stands in the way of our accepting the hypothesis that the reddish violet colour of gold obtained by the Indian goldsmith is due to the formation of a layer of sulphide on the surface. From the fact that if the colouring is allowed to be overdone *i. e.* if the articles be boiled further after the required tint has been obtained, the gold acquires a deep violet colour, the same conclusion is arrived at.

Accordingly, in spite of the fact that the amount of sulphur added regulates the whole operation of the last stage of colouring, we are constrained to search for the reddish violet colour that is developed in the formation of some other compound than a sulphide. The nature of the colour being the same as would be produced by a thin layer of a violet substance on a yellow surface, it follows that the colour of the compound formed must be violet. And the fact that when the colour is overdone, *i. e.* when a thick layer of the coloured

substance is formed on the surface, the appearance of the metal is dark violet, abundantly confirms the hypothesis. The only compoumd of gold that possesses this characteristic colour being aurous oxide Au_2O, we are forced to the conclusion that the colour of gold is due to the formation of a thin layer of suboxide on the surface of the metal.

An examination into the nature of the chemical actions that take place during the operation clearly shows that Au_2O is the compound formed. We have seen in investigating the chemical changes during the third stage of colouring that KNO_3 and NaCl being heated together, yield free chlorine together with KOH and NaOH. This chlorine after being liberated in the fourth stage attacks the gold and a small amount of auric chloride is formed. But at this point sulphur is added, and the nascent chlorine, instead of going to attack the gold any more, combines with the sulphur to form one or more of the sulphur chlorides. The supply of fresh chlorine being thus cut off, the heated auric chloride decomposes into aurous chloride and chlorine. The chlorine thus liberated combines with the sulphur, while the aurous chloride is acted on by the KOH and NaOH with the result that Au_2O is

formed.[1] This is partly deposited on the surface of the gold producing the required colour and partly mixed with the saline solid matter present in the solution.

The series of chemical reactions may be expressed by formula as follows :—

(1) $KNO_3 + 3NaCl + 2H_2O = NOCl + 3NaOH + KOH + Cl_2$; this reaction itself consists of two stages as explained before.



(2) $3Cl + Au = AuCl_3$

(3) $2Cl + S_2 = S_2Cl_2$ (SCl_2 may also be formed in the precence of excess of nascent chlorine).



(4) $Au\ Cl_3 = AuCl + Cl_2$



(5) $2\ AuCl + 2KOH = Au_2O + 2KCl + H_2O$.

It will be observed from the above formula that the addition of sulphur is indispensable in this operation If the excess of chlorine were not removed by sulphur, as is done in (3) above, the gold would continue to be dissolved out and a large loss of the metal would arise as in the course of the third stage.

Moreover, with a free supply of chlorine, the auric chloride would never be reduced to aurous chlo-

(1) The explanation is scarcely satisfactory; it may be taken for what it is worth.

ride, and thus no formation of aurous oxide could take place. It is thus seen that, though the sulphur used is not directly contained in the compound which gives the colour, it regulates the whole reaction in the most important stages of its progress.

The above hypothesis is supported by the fact that if a little sulphur is added to the fluid obtained in the fourth stage of colouring, it will be found to disslove in the fluid. This could not be the case unless a compound like S_2Cl_2, which can hold sulphur in solution, were formed during the re-action.

It has been mentioned above that the loss during the third operation of colouring is considerable. Indeed, from the records of observation given at the end of this section, it is clear that the loss is not only large, but that its extent is also uncertain in the extreme. In some cases it is as low as half a pie per tola, while in others it reaches the ruinous figure of six pies per tola, or nearly one tenth of the whole weight. The average amount of 2½ pies per tola, which is obtained from our figures, is not very different from the idea of experienced *rungwalas* and goldsmiths on the subject. The largeness and uncertainty of loss are easily accounted for by the ever-varying constitution of the bazar articles used in the operation, some of

them being very nearly pure, while others contain as much as 25 to 30 per cent of impurities, as well as by the want of any accurate precision as regards the proportion of materials employed. The ingredients are seldom weighed before being mixed together; and the varying amount of water present physically in the salts is an additional source of error and confusion in settling the proportion by mere inspection of bulk.

The following figures will give some idea as to the magnitude of the loss in colouring:—

Weight before colouring.			Weight after colouring.			Loss.
Tolas.	Annas.	Pies.	Tolas.	Annas.	Pies.	Pies.
6	10	0	6	7	1·5	10·5
3	2	0	2	14	1	15
12	12	1	12	5	3	26
5	3	2	5	2	0	6
3	0	2	2	12	0	18

The Restorative Processes

Having in the previous paragraphs described with tolerable fulness the various sources of loss of gold in the course of its artistic manipulation by the Indian goldsmith and having in each case pointed out the form in which the metal escapes the hold of the worker, we will now turn our eyes to the meth-

ods which now obtain in our country for recovering, as far as possible, the amount of material which is lost. It is perhaps worth while here to point out that to re-obtain the entire amount of lost material is absolutely impossible from the innate property of the extreme divisibility of matter; and our sole object in these restorative operations should be to secure the recovering of the largest amount of metal that can possibly be saved. There are two small classes of men in Bengal who obtain their living by extracting gold from the refuse and bye-products of the goldsmith's workshop. These are the *neharwala* and the *jamakwala* before alluded to. These classes of men are found to cluster in the suburbs of large towns and important centres of jewelry manufactures. In the smaller towns and more insignificant villages, the bye-products have either to be thrown away or to be disposed of in the best manner that the goldsmith can hit upon. Not unfrequently in such cases the goldsmith himself undertakes to play the part of a *jamakwala* and *neharwala* to the best of his abilities. But the unpractised manipulation of processes, which are themselves far from being satisfactory is sure to result always in the loss of a large portion of gold.

We will now proceed to describe the operations

of the *neharwala* and the *jamakwala*. It may, however, be marked here that the immense difficulty in the way of obtaining the slightest information regarding the indigenous methods adopted by these workmen, in the exercise of their profession, can hardly be appreciated by one who has not personally made an attempt to penetrate into the mysteries of any of the trade or manufacturing secrets of India. The unfortunate stagnation of almost all departments of knowledge, art and industry in India that perplexes and mortifies an inquirer, owes its origin to a longstanding and universal spirit of conservatism inherent in our people which, however eloquently defended by orthodox advocates of caste, is manifestly one of the principal causes why the Indian craftsman lags so far behind in the modern race of nations. The healthy broadness of views, resulting from the dissemination of liberal English ideas among the masses, has, indeed, broken some of the most pernicious strongholds of the intellectual monopolies of India; but there are classes of men who still in obscure nooks of society keep to themselves what they regard as the treasures of professional secrets but what, after all, may be mere child's play to the eyes of the scientific world.

To our enquiries about the nature of the *neharwala* and the *jamakwala* the deafest ears were turned. Our attempts to impress upon these people the necessity of the application of chemistry to improve their methods were mere cries in the wilderness. And it was not until we had spent several weeks in constant intercourse with these people that we could begin to collect the information necessary for such an inquiry. Bit by bit we gained from different sources some knowledge of the processes which are given below in a continuous and well-arranged form.

The Neharwala

Now and then the *neharwala* makes his appearance in the goldsmith's workshop, in order to obtain the collected sweepings and other refuse of the rooms, The interval of time varies from one to three months according to the nature of the work that carried on in the rooms as well as to the amount of gold that is manufactured into ornaments. It is useful to state here that every day before work is commenced, the room is swept very clean and the sweepings, instead of being thrown away, are carefully stored up in a corner.

The heap of dust and rubbish thus accumulated from day to day is the chief object of the visit of the *neharwala*. Having inquired as to the amount of gold that has undergone manipulation since the last disposal of sweepings or *nehar* (from this the *neharwala* gets his name) as well as the nature of the articles that were manufactured, he proceeds to settle the price which depends chiefly on these conditions. The *nehar* of twenty tolas of good gold manufactured into articles, which required drawing, beating as well as soldering would generally be disposed of for a single rupee. It may be interesting to observe that a goldsmith, however dishonest in other respects, would never deceive a *neharwala* by selling to him a heap of ordinary rubbish for fear of losing credit and custom in the department of *nehar-selling*.

The next thing that the *neharwala* wants to obtain is the heap of rejected crucibles.

It has been stated before that indigenous crucibles cannot be employed more than once formelting purposes, and hence the number of waste crucibles is not small in our goldsmith's workshop. The nature of the crucibles and the amount of metal melted in each, together with the qualities of the gold, settle the price. We have seen a score of

crucibles of average size selling for eight annas.

If the goldsmith's shop is large, the soot hanging from the ceiling and walls is also purchased.

The last thing that the *neharwala* asks the shopkeeper is whether that day he would give a *taljhar*, by which is meant if he would allow the workmen's mats to be removed and shaken and the space below the mats swept. This operation is ordinarily perfomed once a year. The sweepings thus obtained are again valued. And after paying the prices the *neharwala* returns home with his heavy load, which sometimes reaches the respectable weight of 50 or 60 pounds.

The first thing that the *neharwala* does with his materials is to crush them fine. This is only necessary when earthen lumps of large size are formed and mixed up with the *nehar* in considerable numbers and is dispensed with in most cases where the large pieces are few in number and can be picked up and thrown away.

The second process is to throw the curshed materials into a big earthen pot in which the *nehar* remains immersed in water for a certain number of days, depending on the quality and quantity of the *nehar*. The object of this is to reduce fragments of clay to a fine state of division by which particles

of gold that might otherwise remain imbedded inside the mass of earthy lumps are at once exposed to view.

The next and the main operation is that of working. The thoroughly soaked *nehar* is put in large earthen vessels and more water is added if necessary. The mass is then thoroughly stirred and the lighter earthy material which yet floats when the heavy metallic matter has settled in the bottom, is taken off. By the repetition of this process the solid matter is reduced to a very small bulk. It is then allowed to settle and the water is slowly poured off. The moisture that yet remains is dried up either on fire or in the sun.

When several *nehars* have been separately washed in the preceding way, the remnants of all the washings are mixed together and the mixture in washed once again. This operation is exactly like the preceding but is carried on more carefully and in better vessels. When it has been completed, about one-quarter of the mixture may be perceived to consist of metallic substances.

Among the metals present in this mixture, iron is often found and, as its presence is extremely undesirable when the meterials are placed on the crucible for melting, it is generally got rid of at this

stage. Formerly this was done by picking up the separate bits of iron by fine pincers, but now-a-days the magnet is almost universally used for the purpose.

The next process is that of melting. This is carried on in the ordinary way, care being taken to procure a crucible big enough for the purpose. The earthy matter sticks to the sides of the crucible, while the metallic portion melts and falls to the bottom. A mixture of gold, silver, copper and zinc is thus obtained.

The old method of obtaining pure gold from such a mixture as this is said to have been as curious and interesting as certainly it was laborious and protracted. The alloy was first of all beaten into leaves of extreme thinness, about 5 inches square in size. Each leaf was then covered with a thin layer of a paste of brick dust and common salt. The leaves were finally arranged one above another and exposed to the heat of fire. After a certain number of days, depending on the nature of the alloy and the temperature of the fire, the gold was found to be very nearly pure.

This method has now, however, been entirely superseded by the far easier and more economical process of treating the alloy with strong nitric acid.

For this purpose however, the metal must be obtained in a fine state of division. This is done rather ingeniously by melting the material and, while molten, by suddenly dropping it in water. By this means the metal is at once reduced to a fine powder without the expenditure of any manual labour in the way of hammering. Care, however, should always be taken to see that the vessel of water in which the molten metal is dropped has a wide mouth. On one occasion, at which we were present, the liquid metal was poured into a narrow-mouthed vessel, and the steam suddenly generated was so great and powerful as to very nearly cause an explosion.

The extraction of gold from rejected crucibles is done much in the same fashion. These are pulverised and treated in the same way as ordinary *nehar*. Sometimes the powders of crucibles are mixed up with the common *nehar* to avoid the necessity of a separate series of operations, but more frequently the smallness of their bulk induces the *neharwala* to treat them separately.

THE JAMAKWALA

We will now turn our attention to the methods of the *jamakwala*. He periodically visits the work-

shops of his patron, the *rungwala* from whom he obtains the necessary amount of *jamak* on the payment of a price which depends on the quality and the quantity of gold that has been coloured, as well as the loss of weight that has taken place in the articles during their make. To give an approximate idea of the commercial value of *jamak* it may suffice to state that we once purchased a *jamak* of 20 tolas of sovereign gold (which is 22 carats or 916·66 per mille fine) for one rupee only. We may also observe that the demand of *jamak* is not at present at par with the amount of its supply; and at some of the bigger *rungwala's* working-rooms, one may see big earthen jars full of this substance, collected and stored up for want of purchasers. It may be interesting to add that even in this obscure department of business, the evil genius of man has set to work, and one has to be careful in dealing with a *jamakwala*, if one is a new hand in these affairs.[1] On one occasion we happened to be defrauded and were given a substance as a *jamak* of 35 tolas of gold for what

(1) It may be observed, however, that a *rungwala* would never deceive a *jamakwala* in the same way as he would deceive a stranger for fear of losing credit and custom in the department of jamak-selling.

we considered the modest price of Rs. 2. But the thing turned out to be an imitation *jamak* only and all our best efforts could not discover in it the slightest trace of gold.

Having obtained a sufficient amount of this fluid the *jamakwala* returns home. His first step is to get rid of the fluid part of the *jamak* by boiling it. For this purpose he has got large earthen vessels with wide mouths which can be placed over a fire. When almost the whole amount of water has been evaporated off, he pours out the viscous mass into an open eathern vessel and porceeds to what we shall call the second process of the *jamakwala*.

With the solid matter of the *jamak* obtained by the first operation, the *jamakwala* mixes a small quantity of borax as well as a large amount of a substance known as *poonoor*. The weight of powdered *poonoor* that is thus added is about four times the weight of the *jamak* matter. Having thoroughly mixed these substances with such an amount of cow-dung as is required to give consistency to the material, he forms them into balls of about two or three inches in diameter. He then dries these balls and when perfectly dried they are ready for the third process.

The *poonoor* employed in the above process is a hard quasimetallic substance that can be purchased from certain grocers at the rate of three or four seers per rupee. It is, they say, nothing but a bye-product in the operation of *rupā-pākāno by* which is meant the operation of chemically purifying silver which has been alloyed with a large amount of copper and other metals. The usual method of conducting this operation in our country is to mix up the alloy with a large amount of lead and after melting the whole mass to blow air from above. [This operation, as also the next one, is practically that of cupellation]. The pure silver, it is found, separates in the course of the operation and collects at the bottom, while the partially oxidised lead, together with the impurities which existed originally in the silver constitutes the *poonoor* of trade. We analysed qualitatively a sample of ordinary bazar *poonoor* by the wet way after dissolving it in nitric acid and found it to contain lead, copper and zinc with traces of silver and iron.

The third process of the *jamakwala* is the main step in the reduction of gold. He scoops out on the earth in an open place a hollow of the shape of a hemisphere about a foot in diameter, and having thoroughly smoothed the interior of this hollow, he

covers it with a layer of slaked lime about half an inch thick. After the lime has dried, it presents the appearance of a course white china vessel, imbedded in the earth. In this the balls prepared by the second process are placed. The *jamakwala* then forms a powerful charcoal fire over it and with two or three large pairs of bellows causes the flame to play on the mass below. The lead of the *poonoor* is soon reduced and dissolves, as it were, the reduced gold, silver and copper. A large metallic mass thus collects at the bottom of the hollow, consisting mainly of lead. The blowing is now continued as hard as possible from above and the metal being oxidised to litharge begins to be blown off. The process must be continued till the whole of the lead has passed off and a mixture of gold, silver and copper remains behind. Care should always be taken in this operation to see that the last trace of lead is thoroughly got rid of; for nothing affects so much the ductility and malleability—virtues most important for the purposes of the goldsmith—of gold as a mixture ever so little of lead. Thus "one two-thousandth part renders the metal too brittle for rolling and its very fumes produce a serious effect upon it."[1]

(1) Maunder's Treasury of Science, Article : Gold.

Such is the tedious length and such the laborious and complicated nature of the processes by which the *neharwala* and the *jamakwala* extract precious metal from the large heaps of rejected sweepings and dirt and bye-products of the goldsmith's workshop. But their labours have only the empirical experience of years to guide them and not the acuteness of a well trained scientific mind ; and accordingly we find that a large portion of their work is directed to achieve in a laborious and round-about way an object which a slight knowledge of chemistry enables us to secure in the simplest manner imaginable.

With a view to shorten the labours of the *jamakwala* as far as possible, we began a series of experiments, investigating the properties of the *jamak* and trying to find out the easiest mode of extracting gold therefrom. As the results of our experiments we have found that, working on ordinary plans in the wet way, we can recover an amount of gold, which is equal to, if not in all cases greater than, the quantity which the *jamkawala* can obtain by his expensive and protracted methods.

We need scarcely give the properties and the constituents of the various specimens of *jamak*

which we obtained from the bazar from time to time for experimental purposes. The way in which a *jamak* is formed having been before described in full, the results of analyses will be nothing but tedious. It will be sufficient to observe that in all cases the *jamak* was a clear greenish-yellow liquid of rather thick consistency with a large mass of grey solid matter at the bottom consisting almost wholly of soluble saline matter.

It may be also added that among bases, silver, copper, zinc, gold, aluminium, potassium and sodium were the principal ones that were found; while amongst the acids present, nitric, sulphuric and hydrochloric were recognised in large quantities. Traces of free chlorine could also be found in some of the solution, while perceptible amounts of iron were found in almost all.

The microscopic appearance of *jamak* may be interesting as showing the exact state in which gold exists in the solution. With this view we examined under a miscroscope (magnfying 375 times) a drop of a clear solution of *jamak* as well as an amount of the solid saline matter lying at the bottom. The appearance, in both cases was the the same, only in the latter the crystals were more numerous and closer together. The octahedra

of alum with occasional facets of cubes, the long furrowed and rhombic prisms of nitre and the cubes of common salt were very prominent. Between these, in numbers far less, could be discovered long, transparent needles. These were most probably crystals of double chloride of gold and sodium which is invariably formed when a solution of auric chloride is mixed with chloride of sodium. The constitution of this substance is $AuCl_3$. $NaCl + 2H_2O$, and it is the commercial "non-deliquescent chloride of gold" which is ordinarily sold in one gramme tubes.

Besides the above crystals, we frequently found amorphous particles, wholly or partially opaque. Those that did not transmit light at all were probably particles of dust or other earthy matter which were present in the ingredients in the shape of impurities. But there were others which transmitted a beautiful green light and these were likely to be fine particles of gold. As these were rather few in number, it might be inferred that in the *jamak*, gold existed chiefly in combination. It is also probable that the greatest part exists as $NaAuCl_4 + 2H_2O$.

From a liquid containing such a variety of substances in solution as the *jamak* does, it is no doubt a difficult task to precipitate the gold which is present perhaps in the minutest quantity of all.

The reducing agents that are mentioned by chemists as suited for reducing gold from solutions are exceedingly numerous. Of those that are practically employed, the pricipal ones are ferrous sulphate, oxalic acid, sulphurous acid metallic iron. We tried each of these in a large number of cases and found that ferrous sulphate gives the best result of all. The reaction that takes place during reduction by ferrous sulphate is somethhng like the following :—



$$2AuCl_3 + 6FeSO_4 = 2Au + 2Fe_2\ (SO_4)_3 + Fe_2CL_6.$$

The gold is precipitated as a fine, heavy, black powder and easily settles at the bottom.

At first we used the pure material obtained from the chemists for precipitating *jamak*; but afterwards found that the crude article of the bazar, after being dissolved in water and filtered, yields a solution which serves equally well.

This makes the process a matter of very little expense and with an anna worth of good crystals of *hirakash* (the Bengali name of ferrous sulphate), a *jamak* containing 8 annas weight (for about Rs. 14 worth) of gold can be satisfactorily extracted·

We are far from thinking that in our experimental attempts to extract gold, we were able to catch the whole of the material that was present

in the solution. It is very probable that in the fine state of division, in which the precipitation takes place, a considerable amount of the metal is washed away in the process of collection. But this loss is due to causes of a mere physical nature and can be prevented to a large extent by the use of better and more refined instruments.

It has, however, been ascertained that even with rough instruments the easy and inexpensive mode of wet working gives as good results as the laborious and costly method of the *jamakwala*. The indigenous worker thinks himself fortunate if the amount of gold which he extracts is of twice the value of the *jamak* from which it is obtained, and we are convinced from the results of repeated experiments that the wet method promises in general no less than twice the amount of profit with the advantage of saving time, labour and expense.

Conclusion

The importance of the subject that has been described and discussed in the major portion of the preceding pages is far greater than it appears to be at the outset. Month after month, in Calcutta and in the larger towns of Bengal, considerable quantities of gold undergo transforma-

tion under the goldsmith's hammer; and as every article so manufactured is coloured before being used, the amount of *jamak* that is produced must be large indeed. By a rough calculation we have estimated that about 3500 persons earn their bread in calcutta by following the occupation of a manufacturing Jeweller; and allowing for holidays, illness and want of work it may be safely held that about 2,000 hammers ply on an average every day on gold and silver within the boundaries of Calcutta and its suburbs. Out of these 2,000 hands 1,500 may be supposed to work on the more precious metal of gold alone. On the modest calculation that a man works one-half of a tola of gold in the course of a day, 750 tolas of golden articles are turned out every day in the metropolis. Supposing as we have pointed out before that in colouring only one-half of an anna of weight of gold is dissolved out into the *jamak* per tola, as much as 375 annas or more than 23 tolas of gold are every day dissolved in Calcutta alone. As has been shown before, we have ample reasons to believe that the *jamakwala* can seldom get out as much as one-half the amount of gold that exists in the *jamak* by his crude and imperfect methods. Granting, however, that he can reclaim

so much as two-thirds of the gold lost in colouring, we are still forced to the astonishing conclusion that seven tolas of gold are absolutely lost in the town of Calcutta alone with the lapse of each day.

There can be little doubt that if the whole of the *jamak* that is now thrown away or otherwise washed could be collected and worked on the lines suggested by the newest and the most refined chemical methods, no less than three fourths of the entire loss could be reclaimed. This would amount to some thing like 15 or 16 lakhs of rupees per annum in these hard days of struggle for existence.

This is not the place for giving even the outlines of any elaborate scheme by which the collection of *jamak* and the extraction of gold therefrom may be carried out in practice on an extensive scale.

Business may be commenced at once by setting up a laboratory fitted up for the purpose after the latest fashion, at a convenient station in the centre of the Province and by purchasing the *jamak* that has already accumulated in the hands of the *rungwala*. In the meanwhile agencies may be established in every district for the purchase and storage of *jamak*. When the accumulated

jamak is all exhausted, these agencies will be able to feed the laboratory continually by the supply of fresh *jamak* from time to time, from all parts of the country.

NOTE ON THE SALTS.[1]

Romaka, also called *Sākambarī*, is the salt produced from the Sambar Lake near Ajmere (Dutt).

Sauvarchala: see under saltpetre.

Audbhida (lit. begot of the soil) is the name applied to the saline deposit commonly known as the *reh* efflorescence. It consists "chiefly of sodium chloride and sulphate in varying proportions. In addition there are sometimes carbonate of soda, and we have usually found some magnesian sulphate. In certain localities the last named salt is in very considerable proportion. In other cases nitrate of lime or alkali is present."

"The efflorescences thus produced consist of three groups: 1st, the neutral, which contain no carbonate of soda (these consist chiefly of sodium chloride and sulphate, and frequently magnesium sulphate); 2nd, the alkaline chlorides and sulphates, but no lime or magnesian salt; 3rd, the nitrous efflorescences."—Dr. Center's Note on

[1] See pp. 29, 44 and 127.

Reh quoted in Watt's Dictionary of the "Economic Products of India". Vol. VI. Part I. pp. 410-417.

We have thus a ready explanation of the conversion of mercury and other metals into their chlorides when they were heated in combination with audvida and other salts (see p. 48). The magnesium sulphate would readily yield sulphuric acid, which with sodium chloride and nitre, might be expected to produce aqua regia; (for further information see under "rasakarpúra" or the chlorides of mercury).

Vi*d*a or Vit is at present taken to be the same substance as the kálánimak or "black salt"; it is difficult to ascertain what it stood for at the time of the Charaka and the Susruta. The following account is given in Watt's Dictionary of the Economic Products of India. "BLACK SALT is prepared in upper India chiefly at Bhewani in the Hissar district by heating together in a large earthen pot 82lb of common salt, one pound of the fruit of *Terminalia chebula*, and one pound of *Phyllanthus emblica*, and one pound of sajji (impure carbonate of soda), until by fusion of the salt the ingredients are well mixed, when the pot is removed from the fire and its contents allowed to cool and form a hard cellular mass. This prepa-

ration is used medicinally principally as a digestive." The salt has a reddish brown colour and consists mainly of sodium chloride with traces of sodium sulphate, alumina, magnesia, ferric oxide and sulphide of iron. Most of the samples, we have examined, were found to evolve minute quantities of sulphuretted hydrogen when treated with an acid: even when placed in the mouth the *taste* of this gas was distinctly felt. It is very probable that when the saline mass is fused with the organic matter [T. chebula], a portion of the sodium sulphate is reduced to sulphide, which by double decomposition converts the traces of iron salt present into the sulphide. The sulphide was detected both in the insoluble residue (as FeS) as well as in the aqueous extract.

In the Chemistry of Bubacar, the following salts are mentioned :—

La *classe des sels* renferme onze espèces : le sel commun, que l'on mange, le sel pur, le sel amer, employé par les orfèvres, le sel rouge [1], le sel de naphte [2] le sel gemme proprement dit, le sel indien [3], le sel alcalin, [4], le sel d'urine, le sel de

(1) Sel gemme coloré.

(2) Sel gemme bitumineux.

(3) Salpêtre ?

(4) Carbonate de soude.

cendres [1], le sel de chaux [2]. (La Chimie au moyen âge, T. I. p. 308).

It will be seen, however, that the last 3 or 4 products are in Hindu Chemistry very properly placed under the kshāras or the alkalies (p. 45).

Note on the Killing of Metals

From the time of the Charaka and the Susruta we find metallic preparations in the shape of oxides, sulphides and sometimes chlorides recommended for internal administration. The various formulas, which will be found scatttered throughout above, give us methods for *killing* the metals. [3] But a *killed* metal is not necessarily a compound; it sometimes means a metal deprived of its well characterised physical properties, *e.g.* colour, lustre &c. Thus the Ayurvedic *killed* gold and silver often represent the respective metals in a fine state of division. Take for instance the following recipe from "Rasaratnākara" by Nityanātha :— "Rub gold leaf with 4 times its weight of *killed*

(1) Carbonate de potasse.

(2) Potasse caustique impure

(3) See pp 30-31, 48 72-73

mercury (*i. e.* sulphide of mercury) and sublime the mixture in a closed crucible. On repeating the process 8 times, the gold is killed." (Cf. also the processes described in pp. 105-106). In the preparation of "makaradhvaja" (p. 132, note) the gold, which is left behind, would be regarded in the same light. As the Hindu Iatro-chemists were very particular about the *killing* of the metals being ensured, they had often to hit upon proper tests for securing this purpose. Thus "Rasaratnâkara" says:—"In order to examine whether the mercury has been completely reduced to ashes, it has to be heated over a gentle fire for 3 hours. If the weight remains constant, know then that it has been completely killed." In other words it means that if there be any free mercury present, it would volatilise off and thus there would be a loss in weight. In page 118 will also be found some tests for *killed* iron. The language of a portion of couplets 25-28 is somewhat obscure and the meaning seems to be the very reverse of what the context would suggest; "*killed iron is that which, on being mixed with treacle......honey and heated, does not revert to the natural state.*" By "natural state" the author probably conveys *the state in which it originally was.*

i.e of an oxide, as immediately below he figuratively speaks of *the resurrection of the dead* (p. 120). Indeed, the ideas of the alchemists of the East and the West ran so closely on parallel lines that the best commentary we can offer to the above is the following extract from Hoefer's work, describing the notions current among the old Egyptinas.

"*Expérience.* On brûle, on calcine du plomb ou tout autre métal (excepté l'or et l'argent) au contact de l'air. Le métal perd aussitôt ses propriétés caractéristiques, et se transforme en une substance pulvérulente, en une espèce de cendre ou de chaux. En reprenant ces cendres, qui sont, comme on disait, le résultat de la *mort du métal*, et en les chauffant dans un creuset avec des grains de froment, on voit bientôt le métal renaître de ses cendres, et reprendre sa forme et ses propriétés premières.

"*Conclusion* :—Le métal, que le feu détruit, est *revivifié*[1] par les grains de froment et par l'action de la chaleur. (T. 1. p. 228).

"N'est-ce pas là opérer le miracle de la résurrection ?" T. 1. p. 228

(1) Les mots *revivifier, révivification* sont encore aujourd'hui employés comme synonymes, de *réduction de désoxydation.*

Other "experiences" as well as technical terms have also their exact analogues in the language of the Western alchemists. Thus side by side with the "tests for killed mercury" (p. 74) and the "process for the fixation of mercury" (p. 131) we may quote :

"Viennent ensuite toutes sortes de recettes pour la "combustion" de l'argent, de l'or, du cuivre de l'étain, etc., faisant parfois double emploi avec le le livre II. Rappelons ici que le mot *combustion* signifiait la calcination des métaux en présence de diverses matières spécialement le soufre, le mercure, les sulfures métalliques, etc. Les produits en étaient dès lors fort multiples.—" La Chimie au moyen âge", I. p. 309.

"La calcination du mercure était appelée à cette époque coagulation ou fixation du métal." *Ibid.* p. 154.

The passage in Rasār*n*ava describing the efficacy of the apparatus especially the line "without the use of herbs and drugs mercury can be killed with the aid of an apparatus alone" (p. 67.) is highly significant. It refers no doubt to the formation of the red oxide of mercury, the precipitate *per se*. Cf. "Il s'agit de la fabrication de l'oxyde de

mercure préparé *per se*, c'est-à-dire sans addition d'aucun corps étranger." *Ibid*, p. 154

ON THE HINDU METHOD OF MANUFACTURING CALOMEL; THE HINDU AND JAPANESE METHODS COMPARED—THE EXPLANATION OF THE REACTIONS INVOLVED

According to the Hindu alchemists, there are four kinds of the ash (*bhasma*) of mercury, namely black (*kajjali*, p. 61), red (vemilion), white and yellow.[1] The white variety is often spoken of as rasakapûra or camphor of mercury; it is often found to be almost pure calomel and sometimes a mixture in indefinite proportions of calomel and corrosive sublimate.

The chlorides of mercury are found to be medicinally used from the 12th century downwards and various recipes are given for their preparation. The earliest account seems to occur in Rasārnava (ch. XI. 24), where we find a mixture among other drugs of green vitriol, alum and salt, described as

(1) कृष्णभस्म, रक्तभस्म or रससिन्दूर ; श्वेतभस्म and पीतभस्म Vide—रसेन्द्रसारसंग्रहः what the yellow ash refers to is not easy to make out.

capable of "killing mercury in an instant" (see p. 73). A more detailed description is found in "Rasendrachintāmaṇi" a work which may safely be placed in the 13th-14th century. Says the author Dhundhukanātha : "I am now going to explain the process of preparing rasakarpūra, which is a remedy for all diseases: take a strong earthen pot and fill one-fourth of it with common salt and place over it a mixture of brick-dust, alum and rock-salt. Rub mercury with the juice of Indian aloe and an equal weight of the above mixture into a paste; deposit it in the earthen pot and cover it with the same ingredients. The pot is to be firmly closed with a well-fitting lid. Now apply heat for three days together." [1]

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(1) सर्वरोगहरो कर्पूररसक्रिया —

स्थाल्यां दृढ़घटितायामन्तः परिपूर्य तुर्यलवणांशैः ।
रजेष्टकारजोऽभिमदुपरि सूतस्य तुर्यांशम् ॥
मिलितैरेवं निधाय स्फटिकारी तत्समश्च तल्लोट्टे ।
स्फटिकारिखरलवणैश्चवपुषरसैः कन्याम्बुपरिघृष्टैः ।
कृत्वा पर्पटमुचितं तदुपर्याधाय तदेव पुनः ।
स्फटिकादिकैश्च रजो दद्यादितः स्थालीं रक्षन् ॥
स्थापय तदुपरि पर्परखण्डान् कृत्वा यत्ना ।
दृढ़स्थाल्याच्छाद्य मुद्रयित्वा दिवसत्रितयं विपचेद्विधिना ॥

Another work of the Iatro-chemical period, "Rasendrasârasa*m*graha" describes the following process for obtaining the *svetabhasma* or white ash. "Rub mercury repeatedly with pā*m*su salt (*i. e.* audbhida salt: see p. 243) and the juice of *Euphorbia neriifolia*; place the mixture inside an iron bottle, the mouth of which is closed with a piece of chalk. The bottle is embedded in a mass of salt (cf. the salt-bath, p. 123) and then fire is urged for an entire day. The white deposit in the neck of the bottle is to be collected."[1]

The Bhâvaprakâsa written about 1500 A. D. prescribes calomel in the treatment of *Phiranga-roga* (lit. the disease of the Portuguese *i. e.* syphilis) and gives the following recipe: "Take of purified mercury, *gairika* (red-ochre), brick-dust, chalk, alum, rock-salt, earth from ant-hill, *kshāri lavana* (impure sulphate of soda) and *bhāndaranjika* or red earth used in colouring pots in equal parts, rub together and strain through cloth. Place the mix-

(1) पिष्टं पांशुपटु प्रगाढममलं वज्राम्बुना सैकतः
सूतं धातुकृतं खटीकवलितं तं मध्ये रोधयेत् ।
वल्लाग्निप्रहरं तथा च तले प्रज्वाल्य वह्निं दृढं
पश्चात् शीतमविन्दुकुन्दधवलं भस्मोपरिष्ठं भवेत् ॥

true in an earthen pot, cover it with another pot, face to face, lute the two together with layers of clay and cloth. The pots so luted are then placed on fire, and heated for four days, after which they are opened, and the white camphor-like deposit in the upper part is collected for use." [1]

---

(1) ग्रहगृहसमं कुर्य्यात्प्रत्येकं गैरिकं सुधीः ।
इष्टिकां खटिकां तद्वत्स्फटिकां सिन्धुजन्म च ॥
वल्मीकं क्षारलवणं भाण्डरञ्जकमृत्तिकाम् ।
सर्व्वाण्येतानि सञ्चूर्ण्य वाससा चापि शोधयेत् ॥
एभिश्चूर्णैर्युतं सूतं यावद्यामं विमर्द्दयेत् ।
तच्चूर्णसहितं सूतं स्थालीमध्ये परिक्षिपेत् ॥
तस्याः स्थाल्या मुखे स्थालीमपरां धारयेत्समाम् ।
सवस्त्रकुट्टितमृदा मुद्रयेदनयोर्मुखम् ॥
संशोष्य मुद्रयेद्भूयो भूयः संशोष्य मुद्रयेत् ।
सम्यग्विशोष्य मुद्रां तां स्थाल्यौ चुल्ल्यां विधारयेत् ॥
वह्निं निरन्तरं दद्यादायावद्दिनचतुष्टयम् ।
अङ्गारोपरि तद्यन्त्रं रक्षेद्यत्नादहर्निशम् ॥
शनैरुद्घाटयेद्यन्त्रमूर्द्ध्वस्थालीगतं रसम् ।
कर्पूरवत्सुविमलं गृह्णीयाद्गुणवत्तरम् ॥

The Japanese method has been described by Professor Divers at length[1] and a summary of it is given below in the eminent chemist's own words :—

"The Japanese prepare calomel pure, above all things from corrosive sublimate. They heat balls of porous earth and salt soaked in bittern along with mercury, in iron pots lined with earth. The heat forms hydrochloric acid from the magnesium chloride in the bittern, and the mercury sublimes into the close-fitting but unattached clay covers of the pots. Air enters by diffusion and oxygen and hydrochloric acid gas act together in the hollow cover on the vapour given off from the sublimate of mecury there formed."

It will be seen that the process somewhat approaches that of "Rasendrasārasa*m*graha" in which the pā*m*su salt, which contains magnesium sulphate (see p. 252) sets free hydrochloric acid. The recipe of "Rasendrachintāma*n*i" and Bhāvaprakā*s*a would seem to have their analogue in the Chinese method, for a short account of which we are also indebted to Professor Divers' Memoir :—

The translation from "Bhávaprakása" as given above is by Dutt.

(1) "Journ. Soc., Chem. Ind." Vol. XIII. (1894) pp. 108-11.

"The Chinese process, *if correctly described*, differs from that used in Japan in several material points, one of which is that the mercury is intimately ground up with the other materials, and one fails to see what reaction can take place between it and the two others, namely salt and alum. Heated, the mixture must give off mercury and hydrochloric acid,and then these, as in the Japanese process, will with air give the calomel, but this is independent of the previous intimate mixture of the mercury with the salt and the alum. Another point is that in place of the magnesium chloride of sea-water as the source of hydrochloric acid, the Chinese are said to use alum or copperas, which, with the salt, will react to give hydrochloric acid. A third point is that the cover is said to be closely luted to the iron pot, which must nearly exclude the air, without which it is impossble to explain the formation of calomel. Perhaps this is the reason why the Chinese process is said to take four or five hours' firing, since this may give time enough for the needed oxygen to diffuse through the cup and luting, it will also account for the fact, if it is one, that the yield of calomel is markedly less in weight than the mercury used."

The Chinese and Hindu methods[1] are essentially the same as in both alum plays an important part in that it yields sulphuric acid. Professor Divers in his explanation of the Japanese method supports the view that the hydrochloric acid at first liberated undergoes *aerial* oxidation, thus: $2HCl + O = H_2O + Cl_2$; and it is the chlorine thus set free, which attacks the mercury, forming calomel—a view which has been accepted by no less an authority than Mendeléeff.[2] The author has all along entertained doubts as to the correctness of Divers' hypothesis and he has, in his lectures, pointed out to his students that some "catalytic agent" as in Deacon's process must account for the reaction involved. This now turns out to be so. It is the *ferric*

(1) To which may be added that of the Latin Geber :—

"Argentum vivum sic sublima. Sume de eo libram unam, vitrioli rubificati libras duas, aluminis rochae calcinati libram unam, et salis communis libram semis, et salis petrae quartam partem, et incorporatum sublima, et collige album, densum, clarum et ponderosum, quod circa vasis sponditia inventum fuerit, et serva, ut tibi de aliis scripsimus. Sed si in prima sublimatione inventum fuerit, turbidum vel immundum, quod tibi accidere poterit propter tuam neglegentiam, illud cum eisdem fecibus noveris iterum sublimare, et serva."—"Ges. d. Chem." IV. p. 189.

(2) "Principles of Chemistry," Vol. II. p. 54 (Eng. trans. ed. 1897).

oxide, a constituent of the burnt earth "*mitsuchi*"[1] which really acts as the chlorinating agent, if we may so call it, in that it combines with the hydrochloric acid forming ferric chloride, and the latter in turn dissociates into *ferrous chloride* and *free chlorine.*

The alumina of the clay also plays a similar part. A series of experiments were undertaken to establish this point, the results of which are stated below :—

I. Mercury, intimately rubbed with moist magnesium chloride, was gently heated in a combustion tube in a current of carbonic acid gas: globules of mercury and hydrochloric acid condensed in the cooler parts of the tube, but no calomel was formed.

II. Mercury, intimately mixed with magnesium chloride and a small quantity of jeweller's *rouge*

(1) The composition of the earth, as found in use at the works, but rendered anhydrous, is as follows :—

Quartz	38·4
Combined Silica ...	24·2
Alumina	26·3
Ferric oxide	10·5
Magnesia	0·3
	99·7

(ferric oxide), was treated exactly as above—a crystalline sublimate of calomel was at once obtained, with only a faint trace of corrosive sublimate. There was very little free mercury left.

III. The experiment under ii was repeated, only alumina being substituted for ferric oxide—almost chemically pure calomel was obtained, the yield being rather less.

IV. Mercury, was vapourised in a current of air mixed with hydrochloric acid gas—calomel was formed, but the yield was proportionately very much less than in i; by far the largest amount of mercury volatilised as such and condensed in the cooler parts of the tube as globules.[1]

The formation of calomel as in exp. IV. is, in itself, an interesting reaction and it is rather surprising that Roscoe and Schorlemmer's latest edition of the standard work on Chemistry fails to take

(1) The author avails himself of this opportuntiy to express his indebtedness to Mr. Chandrabhúshana Bhádurí, B.A., Demonstrator, Chemical Dept., Presidency College, with whom he has, of late, had frequent discussions on the chemistry of the Japanese Process. It was Mr. Bhádurí who hit on the true explanation as given above. The experiments i, ii, iii and iv were all performed by him. As Mr. Bhádurí has expressed a desire to work out the subject in all its bearings, we can confidently look forward to some very interesting results.

note of it. Our contention, however, is that the traces of air that would diffuse through the porous lid would give rise to a quantity of calomel which may almost be regarded as negligible. For the true explanation, as we have already pointed out, we should look to the presence of *ferric oxide*. Our view receives additional support from the fact that the residue in exp. ii. was found to contain *ferrous* chloride.

The Chinese method as also that of the Latin Geber recommends the addition of saltpetre as thereby more of corrosive sublimate would be formed than calomel, and this purpose is equally served in the process of Bhāvaprakāsa which uses, over and above brick-dust, *gairika* (red ferruginous earth, see p. 139, thus further increasing the chlorinating capacity. Professor Divers is of opinion that the sulphuric acid set free by alum acts upon sodium chloride giving rise to hydrochloric acid (loc. cit). and does nothing more; our view is that the sulphuric acid simultaneously acts in a two-fold capacity; first, it liberates hydrochloric acid; secondly, it acts upon mercury forming mercurous or mercuric sulphate as the case may be and then double decomposition takes place between the two, thus :



$$Hg_2SO_4 + 2HCl = Hg_2Cl_2 + H_2SO_4$$

The sulphuric acid in turn acts upon a fresh quantity of sodium chloride and mercury and so on. By far the larger portion of the chlorides of mercury would seem, however, to be formed through the agency of the ferric oxide.

The processes of "Rasendrachintâmaṇi" and "Bhâvaprakâśa" were also put to an experimental test, the globules of mercury were broken up by being rubbed continuously with a mixture of brick-dust, alum and common salt, and the mass was transferred to a stout bottle, which was wrapped in several folds of cloth, smeared with clay [1]. The bottle was embedded in sand and heated for 3 hours [2]—*vide* illustration. The sublimate that was obtained was a mixture of calomel and mercuric chloride; in one experiment brick-dust

(1) The experiments were conducted under the author's personal supervision by Kavirâj Prakṛitiprasanna Kaviratna, who is well skilled in the Hindu methods of *killing* metals.

(2) The heating for 3 or 4 days together as recommended in the Hindu method need not be taken seriously, indeed it must be regarded as an *extravaganza* of the old alchemists. Professor Divers in applying his theory of *aerial oxidation* to the Chinese process has been led to suppose that it "takes 4 or 5 hours' firing, since this may give time enough for the needed oxygen to diffuse through the cup and luting."

was omitted and the product was pure calomel [1]. There was necessarily some loss of mercury by volatilisation in these cases and the yield was short of the theoretical quantity. It will be seen that common salt, with alum or green vitriol, is quite competent to convert mercury into calomel; but the addition of brick-dust increases the chlorinating capacity, giving rise to a certain proportion of corrosive sublimate, which can probably be avoided by gentle heating as in the Japanese method.

APPENDIX I

Analysis of some Preparations used in the Hindu Medicine

ÆTHIOPS MINERAL

(Kajjali or rasaparpati p. 61)

As might be expected from its mode of preparation, the substance always contains a large excess of free sulphur.

(1) Dutt writes:—"The white form called *rasakarpûra* is now prepared, not according to the processes described in Sanskrit works, but by subliming the black sulphide of mercury with common or rock salt. In this form it is largely manufactured and sold in all the bazars."

0·645 gram subst; digested with carbon bisulphide, yielded 0·2845g. sulphur: whence free sulphur amounts to nearly 44 per cent.

SULPHIDE OF COPPER

(Parpati tāmram p. 58)

0·704 g. subst., heated in a current of hydrogen with powdered sulphur (Rose's method), till the weight was constant, gave 0·697 g. It is thus evident that this preparation is nearly pure cuprous sulphide (Cu_2S).

CALOMEL.

(Rasakarpūra, p. 250)

Five samples, procured from the market and prepared according to the indigenous method, when exhausted with water gave in the filtrate only faint brown coloration with sulphuretted hydrogen. It is thus evident that these were all free from corrosive sublimate.

Dutt, we are afraid, derived much of his information on chemical subjects from hearsay. By "subliming the black sulphide of mercury with common salt," we got, as we expected, merely *cinnabar*. The sodium chloride was simply left behind. It is to be regretted that the new edition of Dutt's valuable work, which claims to be "revised," reproduces all the glaring errors of the first.

Rust of iron

(Mandūra, p. 111)

Hindu physicians generally procure the scales from the black-smith's forge, which peel off the red-hot bars of iron, when they are struck on the anvil with an iron hammer. These are subjected to further roasting, sometimes as many as 500 times and powdered very fine.

Sample I

The powder was reddish brown in colour; and slightly magnetic; 0·6638 g was boiled a few hours with hydrochloric acid in a current of carbonic acid gas. On adding a drop of potassium ferricyanide solution to a drop of the iron solution, a faint blue colour was noticed. Weight of insoluble residue, which was simply siliceous matter, was equal to 0·107g; the oxide of iron was therefore equal to 0·6638g—0·107g.=0·5568g. The solution, distinctly yellow in colour, was treated with ammonia and the precipitate, ignited in the usual way, weighed 0·560 g. The sample was thus practically ferric oxide (Fe_2O_3).

Sample II.

It was magnetic and of dark iron colour; 0·259g, digested as above with hydrochloric acid, gave as residue (sand &c.) 0·131 g. Wt. of the real oxide=128 g. The solution was treated with ammonia and the precipitate, ignited as usual, weighed 0·130 g. The latter was once more dissolved in HCl and tested with $K_3 Fe Cy_6$; but no indication of a *ferrous* salt was obtained. It is thus evident that both the samples contained only a trace of ferrous oxide.

As a check upon the above analyses, black scales were procured from a smith's and examined. These were carefully sifted by means of an electro-magnet and freed from dust and other foreign impurities. 0·622 g scales was heated in a platinum crucible over a blow-pipe flame and cooled at intervals, till the weight was constant at 0·649g.

Now Fe O. $Fe_2 O_3$ thus becomes Fe O3/2. $Fe_3 O_4$ or 232g " " 240g

Now $0·622 \times \frac{240}{232}$ g=0·643g

The difference between the theoretical amount and that actually found is thus only 6 milligrams. This is no doubt due to the scales enclosing minute traces of *metallic* iron.

In the Hindu method of *killing* and purifying metals, the juices expressed from various plants are frequently used (cf. pp. 61, 132). The ashes of plants rich in potash are also utilised as a source of alkali. (Cf. pp. 35-36). We give below one or two typical analyses.

(i) *Achyranthes aspera* (अपामार्ग) ।

"The ashes are used by the Hindus in preparing alkaline preparations. The diuretic properties of the plant are well known to the natives of India, and European physicians agree as to its value in dropsical affections.

* * * *

Chemical composition.—The whole plant collected in August was used. A proximate analysis failed to indicate the presence of any principle of special interest. No alkaloidal body was detected, and the alcoholic extract contained no principle reacting with ferric salts.

"For the ash determination, the roots, stems and leaves were separately examined with the following results :—

	LEAVES.	STEMS.	ROOTS.
P_2O_5	3·0257	2·6939	1·8504
SiO_2 as Sand	39·7192	12·9716	21·4219
SO_3	1·3200	2·6534	3·9523
CaO	13·8893	13·1233	12·9335
MgO	3·4778	3·5149	5·4419
K_2O	17·8454	32·0008	28·5830
Na_2O	....	....	·9860
Fe_2O_3	2·7931	3·0352	5·6297
Manganese	Traces, not estimated.	Not estimated	Not estimated.
KCl	5·7416	9·5221	....
NaCl	1·1770	1·5261	3·2951
Al_2O_3	2·0651	Not estimated.	Not éstimated.
CO_2	8·8687	13·6294	11·0057
Carbon	·3297	·5525	Not estimated
	100·2526	95·2232	95·1085

"The leaves, stems, and roots dried at 100°C., afforded respectively the following percentages of ash ,—Leaves, 24·334; stems, 8·672; roots, 8·863. The large amount of sand present in the ash is due to the fact of the plants having been collected during the rains, and when received they were coated with finely divided siliceous matter.

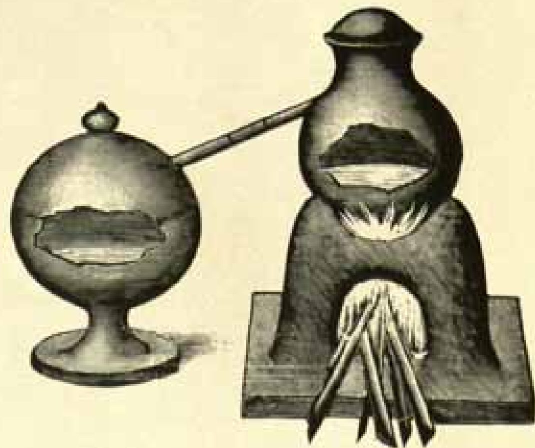
"The total potash calculated as K^2O was equivalent in the leaves to 21·4986 per cent., in the

stems to 38·0122 per cent., and in the roots to 28·5830 per cent. It is possible that the plant might be of value as a cheap green manure on account of potash content. (Warden, *Chem. News*, Vol. ii., 1891)."

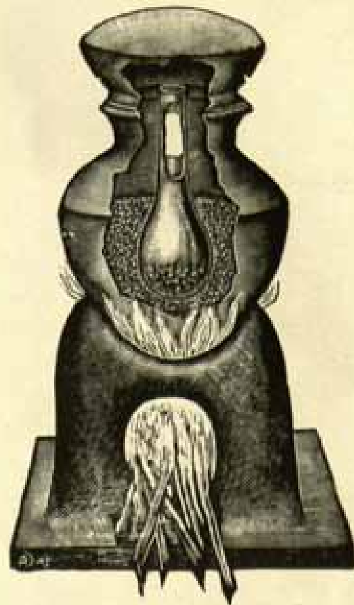
(ii) Juice of *Trianthema monogyna* (श्वेतपुनर्नवा) ।

Although *Punarnava* is *Boerhaavia diffusa*, the plant universally used by our *Kavirajes* as श्वेतपुनर्नवा, is different. A sample was submitted to the authorities of the Royal Botanical Gardens, Sibpur, for examination, and it was indentified as *Trianthema monogyna* (nat. ord. Ficoidæ). On chemical analysis of the juice of the succulent stems, we found it to consist of a large proportion of potassium and sodium chlorides; a nitrate was also detected. The cooling and diuretic properties of the plant are thus easily explained.

APPENDIX II

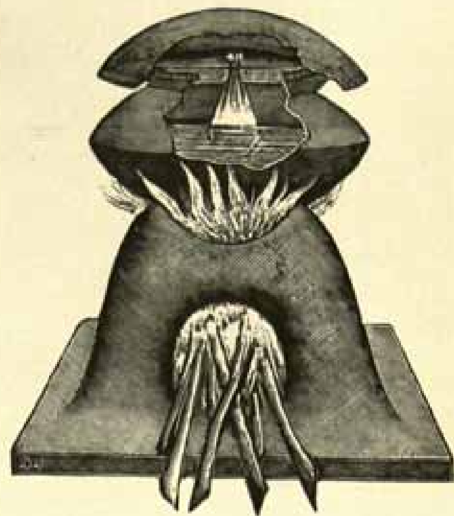


*D*hekī yantra*m*. (See p. 123)



Vālukā yantra*m*. (See p. 123)





Dolā yantra*m*. (See p. 121)



Svedanī yantra*m*. (See p. 122)



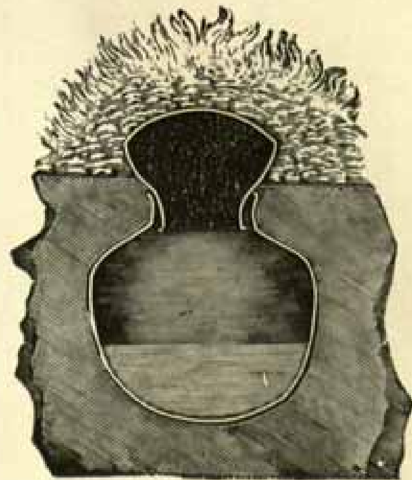
Dhūpa yantram. (See p. 125)

Koshthī apparatus,
for the extraction of zinc from calamine. (See p. 89)

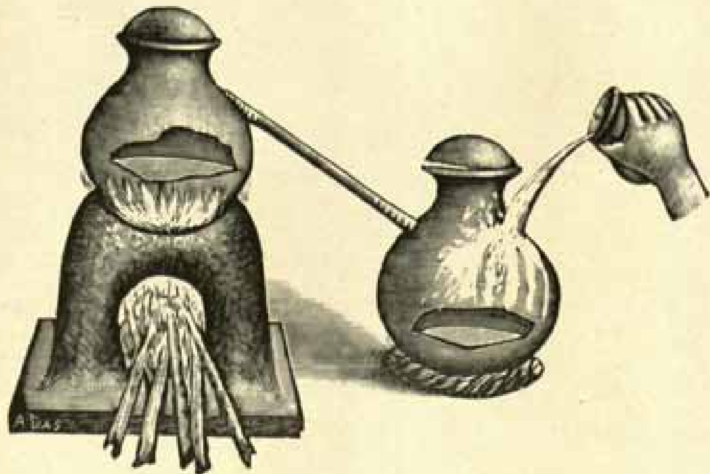




Pātatnā yantra*m*. (See p. 122).



Adhaspātana yantra*m*. (See p. 122).



Vidyādhara yantra*m*. (See p. 124).



Tiryakpātana yantra*m*. (See. p. 124).

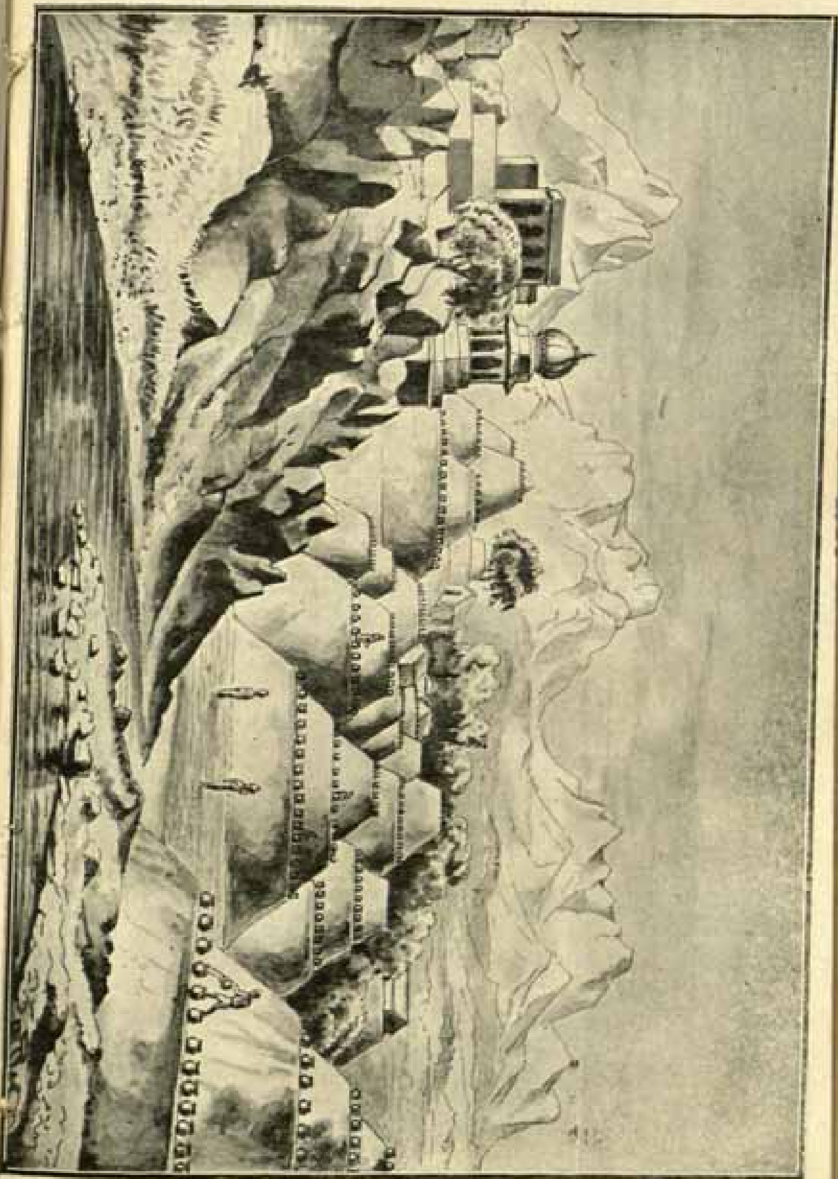
Copper Reducing Furnace at Khetri.

From Ball's Economic Geology of India. (See p. 140-41).



Alum and Sulphate of Copper Works Khetri.

From Ball's Economic Geology of India. (See p. 148).



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SANSKRIT TEXTS

Sanskrit Texts

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Abbreviations used : M. Ms. = Madras Manuscript.
K. Ms. = Kásmír Manuscript.
R. R. S. = Rasaratnasamuchchaya.
Rr. by Nág. = Rasaratnákara by Nágárjuna.

वृन्दलिखितसिद्धयोगादुद्धृतानि वचनानि—

रसेन्द्रेण समायुक्तो रसो धत्तूरपत्रज: ।
ताम्बूलपत्रजो वाथ लेपनं यौकनाशनम् ॥ VI, 13.

त्रिफलाव्योषसिन्धूत्थयष्टीतुत्थरसाञ्जनम् ।
प्रपौण्डरीकं जन्तुघ्नं लोध्रं ताम्रं चतुर्दश ॥
द्रव्याण्येतानि संचूर्ण्य वर्त्तिः कार्य्या नभोऽम्बुना ।
नागार्ज्जुनेन लिखिता स्तम्भे पाटलिपुत्रके ॥
LX, 148-149.

सर्व्वेषां लोहजातानां कान्तं भवति कान्तिदम् ।
* * पाचयेल्लोहमादौ सप्तदिने तत: ॥

धात्रीपिण्डारकोद्भूतस्वरसेनार्करश्मिषु ।
स्थापयेत् * * * ॥
काकमाचीरसे पश्चात् * * ।
पुनर्म्मर्द्ज्जाम्लि सर्व्वंच खलितव्यं प्रयत्नतः ॥
पश्चाच्चूर्णं विधातव्यमप्रमत्तेन धीमता ।
इति सूर्य्यमुखेनैव मारणं परिकीर्त्तितम् ॥
* * * * लौहमारणम् ।
रसगन्धकताम्राणां चूर्णं कृत्वा समांशिकम् ।
पुटपाकविधौ पक्त्वा मधुनालोड्य संलिहेत् ॥
सर्व्वरोगहरश्चैतत्पर्पटाख्यं रसायनम् ॥
पर्पटीताम्रं, रसायनाधिकारः ।
कर्षद्वयं गन्धकस्य तदर्द्धं पारदस्य च ।
विड़ालपदमात्रन्तु लिह्यात्तन्मधुसर्पिषा ॥[1]
रसामृतचूर्णम्, अम्लपित्ताधिकारः ।

(1) The edition of चक्र published by the Anandá-srama Press, Poona, does not contain the last three slokas, which, however, occur in the K. Ms. of the same.

Extracts from Rasarnava

रसार्णवादुद्धृताः श्लोकाः ।

श्रीभैरव उवाच—

रसोपरसलोहानि वसनं काञ्जिकं विड़म् ।
धमनी लोहयन्त्राणि खल्वपाषाणमर्द्दकम् ॥
कोष्ठिका वक्रनालश्च गोमयं सारमिन्धनम् ।[1]
मृन्मयानि च यन्त्राणि मुसलोलूखलानि च ॥
संड़सीयन्त्रसंदंशं सूत्पात्राय:करोटकम् ।[2]
प्रतिमानानि च तुला छेदनानि कषोत्पलम्[3] ॥
वंशनाली लोहनाली मूषामार्गास्तथौषधी ।
स्नेहाम्ललवणचारविषाण्युपविषाणि च ॥

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(1) Cf. कोष्टिका वक्रनालश्च गोमयं सारमिन्धनम् ।

Rr. by Nág. Ch. IV.

(2) M. Ms. reads मल्लपीषडसन्दंशौ मृत्पात्र वैकरोटकम् ।

(3) M. Ms. has कषोत्पलम् ।

एवं संगृह्य सम्भारं कर्म्मयोगं समाचरेत् ॥
द्रवद्द्रव्येण भाण्डस्य पूरितार्द्धोदरस्य च[1] ।
मुखे तिर्य्यक्कृते भाण्डे रसं सूत्रेण लम्बितम् ।
तं स्वेदयेत्तत्र गतं दोलायन्त्रमिति स्मृतम् ॥
लोहमूषाद्वयङ्कृत्वा द्वादशाङ्गुलमानतः ।
ईषच्छिद्रां छिद्रमिता[2]मेकां गन्धकसंयुताम् ॥
मूषायां रसयुक्तायामन्यस्यां तां प्रवेशयेत् ।
तोयं स्यादमृतकस्याध ऊर्द्ध्वाधो वह्निदीपनम् ॥
रसोनकरसं भद्रे यत्नतो वस्त्रगालितम् ।
दापयेत्प्रचुरं यत्नादाप्लाव्य रसगन्धकौ ॥
स्थालिकायां निधायोर्द्ध्वं स्थालीमन्यां दृढ़ां कुरु ।
सन्धिं विलेपयेद्यत्नान्मृदा वस्त्रेण चैव हि[3] ॥

(1) K. Ms. reads भाण्डस्य पूरिताद्धरसेन च। The reading adopted in the text is that of the M. Ms., which quite agrees with R. R. S. (see p. 73, Poona ed.)

(2) M. Ms. reads ईषच्छिद्रान्विताभेकाम्।

(3) Rr. by Nág. reads सन्धौ तु रससंस्थितिः।

स्थाल्यन्तरे कपोताख्यं पुटं कर्षाग्निना सदा ।
यन्त्रस्याधः करीषाग्निं दद्यात्तीव्राग्निमेव च ॥
एवन्तु त्रिदिनं कुर्य्यात्तप्ततोये विमर्द्दयेत् ॥
न तत्र क्षीयते सूतो न च गच्छति कुत्रचित् ।
ऊर्द्ध्वं वह्निरधश्चापो मध्ये तु रससङ्ग्रहः ।
मूषायन्त्रमिदं देवि जारयेद्[1]गन्धकादिकम्[2] ॥
गर्भयन्त्रं प्रवक्ष्यामि पिष्टिकाभस्मकारकम् ।
चतुरङ्गुलदीर्घां[3] च मूषिकां मृन्मयीं दृढाम् ॥

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(1) M. Ms. has जारयेत् ।

(2) गगनादिकम् in R. S. S. (p. 74, Poona ed.) Couplets लोहमूषाद्वयं . . . . गच्छति कुत्रचित् have been borrowed by R. R. S. in the Book on apparatus.

(3) Rr. by Nág. reads—

चतुरङ्गुलदैर्घ्येण विस्तारेण च त्र्यङ्गुलम् ।
मूषान्तु मृन्मयीं कुर्य्यात् सुदृढां वर्त्तुलां बुधः ॥
त्रिंशद्भागानि लोहस्य भागमेकन्तु गुग्गुलोः ।
शुद्धवर्णं पेषयित्वा तु तीव्रं दत्त्वा पुनः पुनः ॥
मूषालेपं दृढं बद्ध्वा लोहार्थे भस्मकां बुधः ।
कुर्य्यात्तुषाग्निं भूमौ च गर्त्तस्वेदेन स्वेदयेत् ॥

अङ्गुलमध्यविस्तारं वर्त्तुलं कारयेन्मुखम् ।
लोहस्य[1] विंशतिर्भागा एकभागस्तु गुग्गुलोः ॥
सुश्लक्ष्णं पेषयित्वा तु तोयं दद्यात्पुनः पुनः ।
मूषालेपं ततः कुर्य्यात्तिलपिष्टञ्च निक्षिपेत्[2] ॥
कुर्य्यात्तुषाग्निं भूमौ च[3] मृदुस्वेदन्तु कारयेत् ।
अहोरात्रं त्रिरात्रं वा रसेन्द्रो भस्मतां व्रजेत् ॥
जारणे मारणे चैव रसराजस्य रञ्जने ।
यन्त्रमेव परं कर्म्म यन्त्रविद्या महाबला ॥[4]
औषधिरहितश्चायं हठाद्यन्त्रेण बध्यते ।
तस्माद्यन्त्रबलञ्चैकं न विलंघ्यं विजानता ॥ 3–24.
खर्परं सिकताकारं कृत्वा तस्योपरि न्यसेत् ॥
अपरं खर्परं तत्र शनैर्मृद्वग्निना पचेत् ॥
पञ्चक्षारैस्तथा मूत्रैर्लवणैश्च विड़ैस्ततः ।
हंसपाकः स विख्यातो[5] यन्त्रतत्त्वार्थकोविदैः ।

(1) K. Ms. reads लोषस्य ।

(2) K. Ms. has तिलपिष्टं सुनिक्षिपेत् ।

(3) M. Ms. reads तुषकर्षाग्निना भूमौ ।

(4) M. Ms. has यन्त्रौषधं परं कर्म्म यन्त्रौषध्या महारसम् ।

(5) M. Ms. reads हंसपाकस्तु विख्यातः ।

कृष्णा रक्ता च पीता च शुक्लवर्णा[1] च मृत्तिका ॥
आद्या श्रेष्ठा कनिष्ठा च मध्यमा मध्यमा मता ॥
दग्धधान्यतुषोपेता मृत्तिका कोष्ठकारिका[2] ।
वक्रनालकृते वापि शस्यते सुरसुन्दरि ॥
गौरा दग्धा तुषा दग्धा दग्धा वल्मीकमृत्तिका ।
अजाश्वानां मलं दग्धं दग्धा सूक्ष्मतां गता ॥
वासकस्य च पत्राणि वल्मीकस्य मृदा सह ।
पेषयेदग्नितोयेन घनेन वज्रतां गतम् ॥
मर्द्दयेत्तेन बध्नीयाद्वक्रनालस्य कोष्ठकम् ॥
गौरा दग्धा तुषा दग्धा दग्धा वल्मीकमृत्तिका ॥
चिरमङ्गारकः किट्टं वज्रेणापि न भिद्यते ।
दग्धाङ्गारस्य षड्भागा भागैका कृष्णमृत्तिका ॥
चिरमङ्गारकः किट्टं वज्रमूषा प्रकीर्त्तिता ॥
तुषदग्धसमा दग्धमृत्तिका चतुरंशिका ।
घर्म्मपाषाणसंयुक्ता[3] वज्रमूषा प्रकीर्त्तिता ॥

(1) M. Ms. has शुक्लकृष्णा ।

(2) M. Ms. reads कोष्ठकारिणी ।

(3) M. Ms. has कृष्णपाषाणसंयुक्ता ।

प्रकाशा चान्धमूषा च प्रकृतिर्द्दिविधा स्मृता ।
प्रकाशमूषा देवेशि शरावाकारसंयुता ॥
द्रव्यनिर्वाहणे सा च वैदिकैः सुप्रशस्यते ॥[1]
अन्धमूषा तु कर्त्तव्या गोस्तनाकारसन्निभा ।
पिधानकसमायुक्ता किञ्चिदुत्तानमस्तका ॥
पत्रलेपे तथा भागे[2] इन्द्रनीलापके तथा ।
सैवाच्छिद्रान्विता मध्ये गम्भीरा सारणोचिता ॥
मोचचारस्य[3] भागौ द्वौ इष्टकांशसमन्वितौ ।
स्फ्राशास्तारशुद्ध्यर्थमुत्तमा वरवर्णिनि ॥ 29–46.
आवर्त्तमाने कनके पीता तारे सिता शुभा ।
शुल्वे[4] नीलनिभा तीक्ष्णे कृष्णवर्णा सुरेश्वरि ॥
वङ्गे ज्वाला कपोता च नागे मलिनधूमता ॥
शैले तु धूसरा देवि आयसे कपिलप्रभा ॥

(1) M. Ms. reads सा चार्वैदिकैर्न प्रशस्यते ।

(2) M. Ms. has रङ्गे ।

(3) M. Ms. reads मोचचारस्य ।

(4) K. Ms. has यक्ष्मे, which seems to be incorrect.

अयस्कान्ते धूमवर्णा सस्यके लोहिता भवेत् ॥
वज्रे नानाविधा ज्वाला सस्यके[1] पाण्डुरप्रभा ॥

न विस्फुलिङ्गा न च बुद्बुदाश्च
यदा न रेखापटलं न शब्दः ।
मूषागतं रत्नसमं स्थिरञ्च
तदा विशुद्धं प्रवदन्ति लोहम् ॥

षोड़शाङ्गुलविस्तीर्णं हस्तमात्रायतं शुभम् ।
धातुसत्त्वनिपातार्थं कोष्ठकं वरवर्णिनि ॥ 49-57.

इति श्रीपार्व्वतीपरमेश्वरसंवादे रसार्णवे रससंहितायां यन्त्रमूषाग्निवर्णनो नाम चतुर्थः पटलः ।

विडाराट्टङ्कणक्षारौ यवक्षारश्च सर्ज्जिका ।
तिलापामार्गकदलीपलाशशिग्रुमोचकाः ।
मूलार्द्रकचिञ्चाश्वत्था इत्तक्षाराः प्रकीर्त्तिताः ॥
V. 35-36.

माक्षिकं विमलं शैलं[2] चपली रसकस्तथा ।

(1) M. Ms. reads सस्यके ।

(2) K. Ms. has शिला ।

सस्यको दरदश्चैव स्रोतोऽञ्जनमथाष्टकम्[1] ।
अष्टौ महारसाः * * * ॥ VII. 2-3.
क्षौद्रगन्धर्वतैलाभ्यां गोमूत्रेण घृतेन च ।
कदलीकन्दसारेण भावितं माक्षिकं मुहुः ।
मूषायां मुञ्चति ध्मातं सत्त्वं शुल्बनिभं मृदु ॥ 12-13.
विमलं शिग्रुतोयेन काचीकासीसटङ्कणैः ।
वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥
मोक्षिकाक्षारसंयुक्तं ध्मापितं मूकमूषया ।
सत्त्वं चन्द्रार्कसङ्काशं प्रयच्छति न संशयः ॥[2] 20-21.
गौरः श्वेतोऽरुणः कृष्णश्चपलस्तु प्रशस्यते ।
हेमाभश्चैव ताराभो विशेषाद्रसबन्धकः ॥

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(1) K. Ms. reads स्रोतोञ्जनकथाष्टकम्, which is incorrect.

(2) विमलं शिग्रुतोयेन काङ्क्षीकासीसटङ्कणैः ।
वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥
मोक्षिकाक्षारसंयुक्तं ध्मापितं मूकमूषगम् ।
सत्त्वं चन्द्रार्कसङ्काशं पतति नात्र संशयः ॥

Rr. by Nág. II. 35, 36.

शेषौ मध्यौ च लाचावच्छीघ्रद्रावौ तु निष्फलौ ।
वङ्गवद्द्रवते वङ्गो चपलस्तेन कीर्त्तितः ॥ 26–27.

मृत्तिकागुड़पाषाणभेदैतो[1] रसकस्त्रिधा ॥ VII. 31.

किमत्र चित्रं रसको रसेन,
* * * भावितः ।
क्रमेण भूत्वा तुरगेण रञ्जितः
करोति शुल्वं[2] त्रिपुटेन काञ्चनम् ॥[3] VII. 34.

ऊर्णालाचातयापथ्या-भूलताधूमसंयुतः ।
मूकमूषागतो ध्मातष्टङ्कणेन समन्वितः ॥
सत्त्वं कुटिलसङ्काशं मुञ्चत्यत्र न संशयः ॥[4]
VII. 37-38.

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(1) M. Ms. has भेदकः ।

(2) M. Ms. reads भस्म ।

(3) This śloka is exactly the same as it is in Rr. by Nág. I. 3.

(4) ऊर्णालाचातयापथ्या-भूलताधूमसंयुतः ।
कमूषागतो ध्मातष्टङ्कणेन समन्वित :
सत्त्वं कुटिलसङ्काशं पतति नात्र संशयः ।
Rr. by Nág. II. 31-32.

सत्वकं * * * *

गन्धशोणितमध्ये वा दिनमेकं निधापयेत् ।
तस्य चूर्णं मधूगानि पादमौभाग्यसंयुतम्[1] ॥
करञ्जतैलमध्यस्थं दिनमेकं निधापयेत् ।
मध्यस्थमन्धमूषायां ध्मापयेत्कोकिलात्रयम् ॥
इन्द्रगोपकसङ्काशं सत्त्वं पतति शोभनम् ॥ VII. 41-44.
गोपित्तेन शतं वारान् सौराष्ट्रीं भावयेत्ततः ॥
धमित्वा पातयेत्सत्त्वं कामणद्यातिगुह्यकम् ॥

VII. 72-73.

* * * शृणु लोहान्यतः परम् ।
सुवर्णं रजतं ताम्रं तीक्ष्णवङ्गभुजङ्गमाः ।
लोहकं षड्विधं तच्च यथापूर्व्वं तदक्षयम् ॥ VII.89-90.
रसजं[2] क्षेत्रजञ्चैव लोहसङ्करजं तथा ।
त्रिविधं जायते हेम चतुर्थं नोपलभ्यते ॥
लोहानां मारणं वक्ष्ये समाहितमना: शृणु ।
* * * * *

(1) M. Ms. reads पादमाक्षाध्यसंयुतम् ।
(2) M. Ms. has रसजं, which is doubtful.

नास्ति तल्लोहमातङ्गो यत्र गन्धककेशरी ।
निहन्याद्गन्धमात्रेण यद्वा माक्षिककेशरी ॥

VII. 138-142.

इति श्रीपार्व्वतीपरमेश्वरसंवादे रसार्णवे रस-संहितायां महारसोपरसरत्नलोहलक्षणसंस्कारनिर्णयो नाम सप्तमः पटलः ।

श्रीभैरव उवाच—

कासीसं सैन्धवं माची सौवीरं व्योषगन्धकम् ।
सौवर्च्चलं व्योषका च मालतीरससम्भव: ॥[1]
शिग्रुमूलरसैः सिक्तो विड़ोऽयं सर्व्वजारणः ।[2]

IX. 2-3.

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(1) M. Ms. has सर्जिका and मालतीनीरसम्भवम् ।

(2) Cf. Rasakalpa II. 51-66. Here व्योषगन्धकौ, सर्जिका and रससंयुतैः seem to be correct.

गन्धतालकसिन्धूत्थचूर्णिकाटङ्कणं तथा ।
क्षारैर्मूत्रैश्च विपचेदयं ज्वालामुखी विड़ः[1] ॥

* * * * *

एवं संगृह्य सम्भारं रसकर्म समाचरेत् ।
तत्समाचक्ष्व देवेशि किमन्यच्छ्रोतुमिच्छसि ॥

IX. 9-20.

इति श्रीपार्व्वतीपरमेश्वरसंवादे रससंहितायां विड़कथनो नाम नवमः पटलः ।

काकमाची जया ब्राह्मी मार्ज्जारी रक्तचित्रकः ।
मण्डूका मुद्गपर्णी च शृङ्गवेरं सशाङ्करम् ॥
देवदाली शङ्खपुष्पी काकजङ्घा शतावरी ।
कुमारी भृङ्गराजश्च निर्गुण्डी श्रीमसन्दरः ।
शूलिनी सूर्य्यपर्णी च गोजिह्वा चीरकञ्चुकः ॥

X. 52-54.

(1) K. Ms. reads भयं ज्वालामुखी विड़ः, which is grammatically incorrect.

तद्रसैः सर्व्वदा[1] पात्यः सप्तधा निर्म्मलो भवेत् ।
यामेन[2] पिष्टिकां कृत्वा पातयेदूर्द्ध्वपातने ।
वङ्गनागौ परित्यज्य शुद्धो भवति सूतकः ॥

X. 55-56.

कासीसतुवरीसिन्धुटङ्कणक्षारसंयुतः ।
पूर्व्वभेषजयोगेन सूतकश्चरति क्षणात् ॥ XI. 24.

सौवर्च्चलञ्च कासीसं सामुद्रं सैन्धवं तथा ।
आसुरी टङ्कणञ्चैव नवसारस्तथैव च ॥
कर्पूरञ्चैव माक्षीकं समभागानि कारयेत् ॥
स्नुह्यर्कदुग्धैर्द्देवेशि मूषालेपन्तु कारयेत् ॥
विड़चूर्णं ततो दत्त्वा कनकं जारयेत्प्रिये ॥

XI. 83-86.

नानावर्णं भवेत्सूतं विहाय घनचापलम् ।
लक्षणं दृश्यते यस्य मूर्च्छितं तं वदन्ति हि ॥
आर्द्रत्वं चपलत्वं[3] च तेजो गौरवचापलम् ।

(1) M. Ms. has मर्द्दितम् ।

(2) M. Ms. reads यामेक ।

(3) M. Ms. reads घनत्वम्, which is preferable.

यस्यैतानि न दृश्यन्ते विद्यात्तं सूतसूतकम् ॥[1]

XII. 197-198.

तीक्ष्णं नागं तथा शुल्वं रसकेन तु रञ्जयेत् ।
समस्तं जायते हेम कुष्माण्डकुसुमप्रभम् ॥ XII. 50.

पञ्चभूतात्मकः सूतस्तिष्ठत्येव सदाशिवः ॥ XII. 78.

भस्मसूतं पलैकञ्च पलमेकञ्च[2] गन्धकम् ।
पुटेन जायते भस्म सिन्दूरारुणसन्निभम् ॥ XIV. 81.

मयूरग्रीवतुल्यञ्च कुङ्कुमं रसकं तथा ।
बालवत्सपुरीषञ्च विषं हालाहलं तथा ॥
रक्तचित्रकचूर्णन्तु समभागानि कारयेत् ।
मर्द्दयेन्मध्यमाम्लेन छायाशुष्कञ्च कारयेत् ॥

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(1) Cf. आर्द्रत्वञ्च घनत्वञ्च चापल्यं गुरुतैजसः ।
यस्यैतानि न दृश्यन्ते तं विद्यात्सूतसूतकम् ॥
नानावर्णो भवेत्सूतं विहाय घनचापलम् ।
लक्षणं दृश्यते यस्य मूर्च्छितं तं वदन्ति हि ॥

Rr. by Nág. IV.

(2) M. Ms. has . . . पलैकं पञ्चगन्धं च ।
ताम्रपात्रेण तं कृत्वा मर्द्दयेल्लोहमुष्टिना ।
सप्तदिनं ततः पाच्यं यावद्यामेन मेलनम् ॥

मधुना सह संयोज्य नागपत्राणि लेपयेत् ।
मूकमूषागतं ध्मातं नागं रञ्जयति क्षणात् ॥
अशोकपत्ररसेन सप्तवारं निषेचयेत् ।
अष्टाविंशतिकल्को वै तैले भूनागसम्भवे ॥
तन्नागं जायते दिव्यं देवाभरणभूषणम् ॥

XVII. 70-74.

Extracts from

Rasaratnasamuchchaya.

B. = Benares Manuscript.
K. = Kásmír Manuscript.

अथ प्रथमोऽध्यायः ।

रसोत्पत्तिः ।

यस्यानन्दभवेन मङ्गलकलासम्भावितेन स्फुर-
द्धाम्ना सिद्धरसामृतेन करुणावीचीसुधासिन्धुना ।
भक्तानां प्रभवप्रसंहृतिजरारोगादिरोगाः क्षणा-
च्छान्तिं यान्ति जगत्प्रधानभिषजे तस्मै परस्मै नमः ॥ 1.

आगम[1]श्चन्द्रसेनश्च लङ्केशश्च विशारदः ।
कपाली मत्तमाण्डव्यौ भास्करः शूरसेनकः ॥

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(1) आगमः, a variant in the Poona ed., which also agrees with B. and K.

रत्नकोषश्च[1] शम्भुश्च सात्त्विको नरवाहनः ।
इन्द्रदो गोमुखश्चैव कम्बलिर्व्याडिरेव च ॥
नागार्जुनः सुरानन्दो नागबोधिर्यशोधनः ।
खण्डः कापालिको ब्रह्मा गोविन्दो लम्पको हरिः ॥
सप्तविंशतिसंख्याका रससिद्धिप्रदायकाः ।
रसाङ्कुशो भैरवश्च नन्दी स्वच्छन्दभैरवः ॥
मन्थानभैरवश्चैव काकचण्डीश्वरस्तथा ।
वासुदेव ऋष्यशृङ्गः[2] क्रियातन्त्रसमुच्चयो ॥
रसेन्द्रतिलको योगी भालुकी मैथिलाह्वयः ।
महादेवो नरेन्द्रश्च वासुदेवो हरीश्वरः[3] ॥ 2-7.
एतेषां कियतोऽन्येषां तन्त्राण्यालोक्य सङ्ग्रहः ।
रसानामथ सिद्धानां चिकित्सार्थोपयोगिनाम् ॥

(1) रत्नघोषश्च, another reading in the Poona ed., which also agrees with B. and K.

(2) चर्पटः, a different reading in the Poona ed., which also agrees with B. and K.

(3) K. reads रत्नाकरहरीश्वरौ, which is probably the correct reading.

सूनुना सिंहगुप्तस्य रसरत्नसमुच्चय: ।
रसोपरसलोहानि यन्त्रादिकरणानि च ॥
शुद्ध्यर्थमपि लोहानां तन्त्रादिकरणानि च ।
शुद्धि: सत्त्वं द्रुतिर्भस्मकरणञ्च प्रवक्ष्यति ॥ 8-10.
हन्ति भक्षणमात्रेण पूर्व्वजन्माघसम्भवम् ।
रोगसङ्घमशेषाणां नराणां नात्र संशय: ॥ 26.
यश्च निन्दति सूतेन्द्रं शम्भोस्तेज: परात्परम् ।
स पतेन्नरके घोरे यावत्कल्पविकल्पनाम् ॥ 29.
पतितो दरदे देशे गौरवादङ्गिवक्त्रत: ।
स रसो भूतले लीनस्तत्तद्देशनिवासिन: ।
तां मृदं पातनायन्त्रे क्षिप्त्वा सूतं हरन्ति च ॥
89-90.

इति श्रीवैद्यपतिसिंहगुप्तस्य सूनोर्वाग्भटाचार्य्यस्य कृतौ रसरत्नसमुच्चये रसोत्पत्तिर्नाम प्रथमोऽध्याय: ।

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अथ द्वितीयोऽध्यायः ।

महारसाः ।

अभ्रवैक्रान्तमाक्षीकविमलाद्रिजसस्यकम् ।
चपलो रसकश्चेति ज्ञात्वाष्टौ सङ्ग्रहेद्रसान् ॥ 1.
पिनाकं नागमण्डूकं वज्रमित्यभ्रकं मतम् ।
श्वेतादिवर्णभेदेन प्रत्येकं तच्चतुर्व्विधम् ॥ 5.
श्वेतं रक्तञ्च पीतञ्च कृष्णमेवं चतुर्व्विधम् ॥ 10.
सुखनिर्म्मोच्यपत्रञ्च तदभ्रं शस्तमीरितम् ॥ 12.
सचन्द्रिकञ्च किट्टाभं व्योम न ग्रासयेद्रसम् ।
ग्रसितञ्च नियोज्योऽसौ लोहे चैव रसायने ॥ 13.
निश्चन्द्रिकं मृतं व्योम सेव्यं सर्व्वगदेषु च ।
सेवितं चन्द्रसंयुक्तं मेहं मन्दानलं चरेत् ॥ 14.
प्रतप्तं सप्तवाराणि निक्षिप्तं काञ्जिकेऽभ्रकम् ।
निर्दोषं जायते नूनं प्रक्षिप्तं वापि गोजले ।
त्रिफलाक्वथिते चापि गवां दुग्धे विशेषतः ॥ 17-18.
चूर्णाभ्रं शालिसंयुक्तं वस्त्रबद्धं हि काञ्जिके ।
निर्यातं मर्द्दनाद्धस्ताद्धान्याभ्रमिति कथ्यते ॥ 23.

धान्याभ्रं कासमर्द्दस्य रसेन परिमर्द्दितम् ।
पुटितं दशवारेण म्रियते नात्र संशयः ॥ 24.

अथ वैक्रान्तः—

अष्टास्रश्चाष्टफलकः षट्कोणो मसृणो गुरुः ।
शुद्धमिश्रितवर्णैश्च युक्तो वैक्रान्त उच्यते ॥
श्वेतो रक्तश्च पीतश्च नीलः पारावतच्छविः ।
श्यामलः कृष्णवर्णश्च कर्वुरश्चाष्टधा हि सः ॥ 55-56.

आयुःप्रदश्च बलवर्णकरोऽतिवृष्यः
प्रज्ञाप्रदः सकलदोषगदापहारी ।
दीप्ताग्निकृत् पविसमानगुणस्तरस्वी
वैक्रान्तकः खलु वपुर्बललोहकारी ॥

रसायनेषु सर्व्वेषु पूर्व्वगण्यः प्रतापवान् ।
वज्रस्थाने नियोक्तव्यो वैक्रान्तः सर्व्वदोषहा ॥
57-58.

* * वैक्रान्तं वज्राकारं महारसम् ।
विन्ध्यस्य दक्षिणे वाऽस्ति ह्युत्तरे वाऽस्ति सर्व्वतः ।
विक्रामयति लोहानि तेन वैक्रान्तकः स्मृतः ॥
60-61.

वैक्रान्तकाः स्युस्त्रिदिनं विशुद्धाः
संस्वेदिताः क्षारपटूनि दत्त्वा ।
अम्लेषु मूत्रेषु कुलत्थरम्भा-
नीरेऽथवा कोद्रववारिपक्काः ॥
कुलत्थक्वाथसंस्विन्नो वैक्रान्तः परिशुध्यति ।
म्रियतेऽष्टपुटैर्गन्धनिम्बुकद्रवसंयुतः ॥ 67-68.
भस्मीभूतन्तु वैक्रान्तं वज्रस्थाने नियोजयेत् ॥
मोचमोरटपालाशक्षारगोमूत्रभावितम् ।
वज्रकन्दनिशाकल्कफलचूर्णसमन्वितम् ।
तत्कल्कं टङ्कणं लाक्षाचूर्णं वैक्रान्तसम्भवम् ॥ 70-71.
नवसारसमायुक्तं मेषशृङ्गीद्रवान्वितम् ।
पिण्डितं मूकमूषस्थं ध्मापितञ्च हठाग्निना ॥ 72.
तत्रैव पतति सत्त्वं वैक्रान्तस्य न संशयः ॥ 73.

अथ माक्षिकम्—

सुवर्णशैलप्रभवो विष्णुना काञ्चनो रसः ।
तापी[1]किरातचीनेषु यवनेषु च निर्मितः ॥ 77.

(1) ताप्यी, a variant in the Poona ed., which also agrees with B. and K.

माक्षिकं द्विविधं हेममाक्षिकन्तारमाक्षिकम् ।
तत्राद्यं माक्षिकं कान्यकुब्जोत्थं स्वर्णसन्निभम् ॥ 80.
पाषाणबहुलः प्रोक्तस्ताराख्योऽल्पगुणात्मकः ॥ 81.
मातुलुङ्गाम्बुगन्धाभ्यां पिष्टं मूषोदरे स्थितम् ।
पञ्चक्रोड़पुटैर्दग्धं म्रियते माक्षिकं खलु ॥ 84.
क्षौद्रगन्धर्व्वतैलाभ्यां गोमूत्रेण घृतेन च ।
कदलीकन्दसारेण भावितं माक्षिकं मुहुः ।
मूषायां मुञ्चति ध्मातं सत्त्वं शुल्वनिभं मृदु ॥[1]
89–90.

अथ विमलः—

विमलस्त्रिविधः प्रोक्तो हेमाद्यस्तारपूर्व्वकः ।
तृतीयः कांस्यविमलस्तत्तत्कान्त्या स लक्ष्यते ॥ 96.
वर्त्तुलः कोणसंयुक्तः स्निग्धश्च फलकान्वितः ॥ 97.
गन्धाश्मलकुचाम्लैश्च म्रियते दशभिः पुटैः ॥ 100.
सटङ्कलकुचद्रावैर्मेषशृङ्ग्याश्च भस्मना ।
पिष्टा मूषोदरे लिप्तः संशोष्य च निरुध्य च ॥

(1) Verses 89–90 as also 103–104 occur both in Rasárnava and Rr. by Nág.; the Poona ed. reads पतते नात्र संशयः in the place of प्रयच्छति न संशयः ।

षट्प्रस्थकोकिलैर्ध्मातो विमलः सीससन्निभः[1] ।
सत्त्वं मुञ्चति तद्युक्तो रसः स्याच्च रसायनः ॥
101-102.

विमलं शिग्रुतोयेन कांक्षीकासीसटङ्कणैः ।
वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥
मोचकक्षारसंयुक्तं ध्मापितं मूकमूषगम् ।
सत्त्वं चन्द्रार्कसङ्काशं प्रयच्छति न संशयः ॥
103-104.

अथ शिलाधातुः—

शिलाधातुर्द्विधा प्रोक्तो गोमूत्राद्यो रसायनः ।
कर्पूरपूर्वकश्चान्यस्तत्राद्यो द्विविधः पुनः ॥ 109.
ग्रीष्मे तीव्रार्कतप्तेभ्यः पादेभ्यो हिमभूभृतः ।
स्वर्णरूप्यार्कगर्भेभ्यः शिलाधातुर्विनिःसरेत् ॥
110-111.

अथ सस्यकम्—

मयूरकण्ठवच्छायं भाराढ्यमतिशस्यते ॥ 127.

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(1) Both the B. and K. Mss. read सीससन्निभः। The Poona ed. gives a variant शीससन्निभः।

मयूरतुत्थम्—

रसायनं वमनरेककरं गरघ्नं

श्वित्रापहं गदितमत्र मयूरतुत्थम् ॥ 129.

लकुचद्रावगन्धाश्मटङ्कणेन समन्वितम् ।

निरुध्य मूषिकामध्ये ध्मयते कौक्कुटैः पुटैः ॥ 132.

सस्यकस्य तु चूर्णन्तु पादसौभाग्यसंयुतम् ।

करञ्जतैलमध्यस्थं दिनमेकं निधापयेत् ॥

मध्यस्थमन्धमूषाया[1] ध्मापयेत्कोकिलत्रयम् ।

इन्द्रगोपाकृति चैव सत्त्वं भवति[2] शोभनम् ॥133-134.

निम्बुद्रवाल्पटङ्काभ्यां मूषामध्ये निरुध्य च ।

ताम्ररूपं परिध्मातं सत्त्वं मुञ्चति सस्यकम् ॥ 135.

शुद्धं सस्यं शिखिकान्तं[3] पूर्व्वभेषजसंयुतम् ।

नानाविधानयोगेन सत्त्वं मुञ्चति निश्चितम् ॥ 136.

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(1) The Poona ed. reads यन्धमूषामध्यस्थम् । We have adopted the reading of Rasárnava.

(2) पतति, another reading in the Poona ed., which also agrees with B. K. and Rasárnava.

(3) The Poona ed. reads शिखाकान्तम् ।

अथ चपलः—

गौरः श्वेतोऽरुणः कृष्णश्चपलस्तु चतुर्विधः ।
हेमाभश्चैव ताराभो विशेषाद्रसबन्धनः ॥ 143.
शेषौ तु मध्यौ लाचावच्छीघ्रद्रावौ तु निष्फलौ ।
वङ्गवद्द्रवते वह्नौ चपलस्तेन कीर्त्तितः ॥[1] 144.
चपलः स्फटिकच्छायः षड़स्रः[2] स्निग्धको गुरुः ॥
146.

अथ रसकः—

रसको द्विविधः प्रोक्तो दुर्दुरः कारवेल्लकः ।
सदलो दुर्दुरः प्रोक्तो निर्दलः कारवेल्लकः ॥ 149.
खर्परः परिसन्तप्तः सप्तवारं निमज्जितः ।
वीजपूररसस्यान्तर्निर्म्मलत्वं समश्नुते ॥
नृमूत्रे वाश्वमूत्रे वा तक्रे वा काञ्जिकेऽथवा ।
प्रताप्य मज्जितं सम्यक् खर्परं परिशुध्यति ॥154-155.

Slokas 143 and 144 are from Rasárnava.

(2) षड्स्रः, another reading in the Poona ed. which we have adopted. Slokas 143–146 are evidently borrowed with slight modifications from Rasárnava, VII. 26-27.

हरिद्रात्रिफलारालसिन्धुभूमैः सटङ्कणैः ।
सारुष्करैश्च पादांशैः साम्रैः सम्मर्द्य खर्परम् ॥
लिप्तं वृन्ताकमूषायां शोषयित्वा निरुध्य च ।
मूषां मूषोपरि[1] न्यस्य खर्परं प्रधमेत्ततः ॥
खर्परे प्रहृते ज्वाला भवेन्नीला सिता यदि ।
तदा सन्दंशतो मूषां धृत्वा कृत्वा त्वधोमुखीम् ।
शनैरास्फालयेद्भूमौ यथा नालं न भज्यते ॥
वङ्गाभं पतितं सत्त्वं समादाय नियोजयेत् ॥

157-161.

लाक्षागुडासुरीपथ्याहरिद्रासर्जटङ्कणैः ।
सम्यक्सञ्चूर्ण्य तत्पक्वं गोदुग्धेन घृतेन च ।
वृन्ताकमूषिकामध्ये निरुध्य गुटिकाकृति ।
ध्मात्वा ध्मात्वा समाकृष्य ढालयित्वा शिलातले ।
सत्त्वं वङ्गाकृति ग्राह्यं रसकस्य मनोहरम् ॥

163-164.

(1) मूषां मूषोपरि, a variant in the Poona ed., which also agrees with B. and K.

यदा जलयुतां स्थालीं निखनेत्कोष्ठिकोदरे ।
सच्छिद्रं तन्मुखे मल्लं तन्मुखेऽधोमुखं[1] क्षिपेत् ।
मूषोपरि शिखित्रांश्च प्रक्षिप्य प्रधमेद्दृढम् ।
पतितं स्थालिकानीरे सत्त्वमादाय योजयेत् ॥

165-166.

तत्सत्त्वं तालकोपेतं प्रक्षिप्य खलु खर्परे ।
मर्दयेल्लोहदण्डेन भस्मीभवति निश्चितम् ॥ 167-168.

अथ तृतीयोऽध्यायः ।

अथोपरसाः साधारणरसाश्च ।

अथ गन्धकः—

गन्धाश्मगैरिकाकासीसकाक्षीतालशिलाञ्जनम् ।
कङ्कुष्ठञ्चेत्युपरसाश्चाष्टौ पारदकर्म्मणि ॥ 1.

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(1) तन्मुखेऽधोमुखं, a variant in the Poona ed., which we have adopted.

स चापि त्रिविधो देवि शुकचञ्चुनिभो वरः ।
मध्यमः पीतवर्णः स्याच्छुक्लवर्णोऽधमः प्रिये ॥ 12.
चतुर्द्धा गन्धको ज्ञेयो वर्णैः श्वेतादिभिः खलु ।

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दुर्लभः कृष्णवर्णश्च स जरामृत्युनाशनः ॥ 13-15.
गन्धको द्रावितो भृङ्गरसे क्षिप्तो विशुध्यति ॥ 23.
स्थाल्यां दुग्धं विनिक्षिप्य मुखे वस्त्रं निरुध्य च ।
गन्धकं तत्र निक्षिप्य चूर्णितं सिकताकृति ।
छादयेत्पृथुदीर्घेण खर्परेणैव गन्धकम् ॥
ज्वालयेत्खर्परस्योर्द्धं वनच्छागैस्तथोपलैः ।
दुग्धे निपतितो गन्धो गलितः परिशुध्यति ॥ 24-25.

अथ गैरिकम्—

पाषाणगैरिकञ्चैकं द्वितीयं स्वर्णगैरिकम् ।
पाषाणगैरिकं प्रोक्तं कठिनं ताम्रवर्णकम् ॥ 46.
गैरिकन्तु गवां दुग्धैर्भावितं शुद्धिमृच्छति ॥ 49.

अथ कासीसम्—

कासीसं बालुकाद्येकं पुष्पपूर्व्वमथापरम् । 51.
तुवरीसत्त्ववत्सत्त्वमेतस्यापि समाहरेत् ॥ 54.

अथ तुवरी—

सौराष्ट्राश्मनि सम्भूता[1] मृत्स्ना सा तुवरी मता ।
वस्त्रेषु लिप्यते यासौ मञ्जिष्ठारागबन्धिनी ॥
* * फुल्लिका चेति द्वितीया परिकीर्त्तिता ।
ईषत्पीता गुरुस्निग्धा * * *
निर्भारा शुभ्रवर्णा च स्निग्धा साम्लापरा मता ।
सा फुल्लतुवरी प्रोक्ता लेपात् ताम्रं चरेद्‌यः ॥59-62

काङ्क्षी कषाया कटुकाम्लकण्ठ्या
केश्या व्रणघ्नी विषनाशनी च ।
श्वित्रापहा नेत्रहिता त्रिदोष-
शान्तिप्रदा पारदजारणी च ॥ 63.

तुवरी काञ्जिके क्षिप्ता त्रिदिनाच्छुद्धिमृच्छति ।
क्षाराम्लैर्मर्दिता ध्माता सत्त्वं मुञ्चति निश्चितम् ॥64.
गोपित्तेन शतं वारान् सौराष्ट्रीं भावयेत् ततः ।
धमित्वा पातयेत् सत्त्वं क्रामणं चातिगुह्यकम् ॥65.

(1) सौराष्ट्राश्मनि, a variant in the Poona ed., which also agrees with B. and K.

अथ तालकम्—

हरितालं द्विधा प्रोक्तं पत्राख्यं [1]पिण्डसंज्ञकम् ।
स्वर्णवर्णं गुरु स्निग्धं तनुपत्रं च भासुरम् ॥ 66.
स्विन्नं कुष्माण्डतोये वा तिलक्षारजलेऽपि वा ।
तोये वा चूर्णसंयुक्ते दोलायन्त्रेण शुध्यति ॥ 69.
मधुतुल्ये घनीभूते कषाये ब्रह्ममूलजे ।
त्रिवारं तालकं भाव्यं पिष्ट्वा मूषेऽथ माहिषे ॥
उपलैर्दशभिर्देयं पुटं रुद्ध्वाथ पेषयेत् ।
एवं द्वादशधा पाच्यं शुद्धं योगेषु योजयेत् ॥74-75.
पत्रालकं रवेर्दुग्धैर्दिनमेकं विमर्दयेत् ।
चिञ्चा षोड़शिकातैले मिश्रयित्वा ततः पचेत् ॥
अनावृतप्रदेशे च सप्तयामावधि ध्रुवम् ।
स्वाङ्गशीतमधःस्थं च सत्त्वं श्वेतं समाहरेत् ॥80-81.

अथ मनःशिला—

षष्टमांशेन किट्टेन गुड़गुग्गुलुसर्पिषा ।
कोष्ठ्यां रुद्ध्वा दृढं ध्मात्वा सत्त्वं मुञ्चेन्मनःशिला ॥95.

(1) The Poona ed. reads पत्राढं and K. reads पत्राख्यं, which we have adopted.

अथाञ्जनानि—

सौवीरमञ्जनं प्रोक्तं रसाञ्जनमतः परम् ।
स्रोतोऽञ्जनं तदन्यच्च पुष्पाञ्जनकमेव च ॥
नीलाञ्जनं च तेषां हि स्वरूपमिह वर्ण्यते ।
सौवीरमञ्जनं धूम्रं रक्तपित्तहरं हिमम् ॥ 98-99.
अञ्जनानि विशुध्यन्ति भृङ्गराजनिजद्रवैः ।
मनोह्वासत्त्ववत् सत्त्वमञ्जनानां समाहरेत् ॥
वल्मीकशिखराकारं भङ्क्ते नीलोत्पलद्युति ।
घृष्टं तु गैरिकच्छायं स्रोतोजं लक्षयेद्बुधः ॥
गोशकृद्रसमूत्रेषु घृतक्षौद्रवसासु च ।
भावितं बहुशस्तच्च शीघ्रं बध्नाति सूतकम् ॥ 105-107

अथ कङ्कुष्ठम्—

हिमवत्पादशिखरे कङ्कुष्ठमुपजायते । 109.
केचिद्वदन्ति कङ्कुष्ठं सद्योजातस्य दन्तिनः । 111.
वदन्ति श्वेतपीताभं तदतीवविरेचनम् । 112.

अथ साधारणरसाः—

कम्पिल्लश्च परो गौरीपाषाणो नवसारकः ।
कपर्दो वह्निजारश्च गिरिसिन्दूरहिङ्गुलौ ॥

सूहारस्तङ्कमित्यष्टौ साधारणरसाः स्मृताः ।
रससिद्धिकराः प्रोक्ता नागार्जुनपुरःसरैः ॥ 120 121.

अथ कम्पिल्लः—

इष्टिकाचूर्णसङ्काशश्चन्द्रिकाढ्योऽतिरेचनः ।
सौराष्ट्रदेशे चोत्पन्नः स हि कम्पिल्लकः स्मृतः ॥122

अथ गौरीपाषाणः—

स्फटिकाभश्च शङ्खाभो हरिद्राभस्त्रयः स्मृताः ।
तालवद्दारयेत् सत्त्वं शुद्धं शुभ्रं प्रयोजयेत् ॥124-126.

अथ नवसारः—

करीरपीलुकाष्ठेषु पच्यमानेषु चोद्भवः ।
क्षारोऽसौ नवसारः स्याच्चूलिकालवणाभिधः ॥
इष्टिकादहने जातं पाण्डुरं लवणं लघु ।
तदुक्तं नवसाराख्यं चूलिकालवणं च तत् ।
रसेन्द्रजारणं लोहद्रावणं जठराग्निकृत् ॥
गुल्मप्लीहास्यशोषघ्नं भुक्तमांसादिजारणम् ।127 129.

अथ वराटकाः—

पीताभा ग्रन्थिका पृष्ठे दीर्घवृत्ता वराटिका ।
रसवैद्यैर्विनिर्दिष्टा सा चराचरसंज्ञिका ॥ 130.

वराटाः काञ्जिके स्विन्ना यामाच्छुद्धिमवाप्नुयुः ॥134

अथाग्निजारः—

समुद्रेणाग्निनक्रस्य जरायुर्बहिरुज्झितः ।

संशुष्को भानुतापेन सोऽग्निजार इति स्मृतः ॥ 135

अथ गिरिसिन्दूरम्—

महागिरिषु चाल्पांशः पाषाणान्तःस्थितो रसः ।137

अथ हिङ्गुलः—

एतस्मादाहृतः सूतो जीर्णगन्धसमो गुणैः ॥ 141.

दरदः पातनायन्त्रे पातितश्च जलाश्रये ।

तत्सत्त्वं सूतसङ्काशं पातयेन्नात्र संशयः ॥ 144.

अथ मृद्दारशृङ्गकम्—

सदलं पीतवर्णं च भवेद्गुर्जरमण्डले ।

अर्बुदस्य गिरेः पार्श्वे जातं मृद्दारशृङ्गकम् ॥

सीससत्त्वं गुरु श्लेष्मशमनं पुंगदापहम् ।

रसबन्धनमुत्कृष्टं केशरञ्जनमुत्तमम् ॥

साधारणरसाः सर्वे मातुलुङ्गार्द्रकाम्बुना ।

त्रिरात्रं भाविताः शुष्का भवेयुर्दोषवर्जिताः ॥

145-147.

अथ राजावर्त्तः—

राजावर्त्तोऽल्परक्तोरुनीलिममिश्रितप्रभः[1] । 149.

लुङ्गाम्बुगन्धकोपेतो राजावर्त्तो विचूर्णितः ।

पुटनात्सप्तवारेण राजावर्त्तो मृतो भवेत् ॥ 153.

अथ चतुर्थोऽध्यायः ।

अथ रत्नानि ।

अथ मणयः—

मणयोऽपि च विज्ञेयाः सूतबन्धस्य कारकाः ।

वैक्रान्तः सूर्य्यकान्तश्च हीरकं मौक्तिकं मणिः ॥

चन्द्रकान्तस्तथा चैव राजावर्त्तश्च सप्तमः ।

गरुडोद्गारकश्चैव ज्ञातव्या मणयस्त्वमी ॥

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(1) नीलिमानिर्मिश्रितप्रभः, another reading in the Poona ed., which agrees with B. and K., but it is grammatically inaccurate.

पुष्परागं महानीलं पद्मरागं प्रवालकम् ।
वैदूर्य्यं च तथा नीलमेते च मणयो मताः ॥ 13.

अथ वज्रम्—

वज्रं च त्रिविधं प्रोक्तं नरो नारी नपुंसकम् ।
पूर्व्वं पूर्व्वमिह श्रेष्ठं रसवीर्य्यविपाकतः ॥ 26.
अष्टास्रं चाष्टफलकं षट्कोणमतिभासुरम् ।
अम्बुदेन्द्रधनुर्वारितरं पुंवज्रमुच्यते ॥ 27.
तदेव चिपिटाकारं स्त्रीवज्रं वर्त्तुलायतम् ।
वर्त्तुलं कुण्ठकोणाग्रं किञ्चिद्गुरु नपुंसकम् ॥ 28.
श्वेतादिवर्णभेदेन तदेकैकं चतुर्विधम् ।
ब्रह्मक्षत्रियविट्शूद्रं स्वस्ववर्णफलप्रदम् ॥ 30.

आयुःप्रदं झटिति सद्गुणदं च वृष्यं
दोषत्रयप्रशमनं सकलामयघ्नम् ।
सूतेन्द्रबन्धवधसद्गुणकृत् प्रदीपं
मृत्युञ्जयं तदमृतोपममेव वज्रम् ॥ 32.

कुलत्थक्वाथके स्विन्नं कोद्रवक्वथितेन वा ।
एकयामावधि स्विन्नं वज्रं शुध्यति निश्चितम् ॥

वज्रं मत्कुणरक्तेन चतुर्वारं विभावितम् ।
सुगन्धिमूषिकामांसैर्वर्त्तितैः परिवेष्ट्य च[1] ॥
पुटेत् पुटैर्वराहाख्यैस्त्रिंशद्वारं ततः परम् ।
ध्मात्वा ध्मात्वा शतं वारान् कुलत्थक्वाथके क्षिपेत् ॥
अन्यैरुक्तः शतं वारान् कर्त्तव्योऽयं विधिक्रमः ॥ 34-37.
कुलत्थक्वाथसंयुक्तलकुचद्रवपिष्टया ।
शिलया लिप्तमूषायां वज्रं क्षिप्त्वा निरुध्य च ।
अष्टवारं पुटेत् सम्यग्विशुष्कैश्च वनोपलैः ।
शतवारं ततो ध्मात्वा निक्षिप्तं शुद्धपारदे ।
निश्चितं म्रियते वज्रं भस्म वारितरं भवेत् ॥ 38-39.
सत्यवाक् सोमसेनानीरेतद्वज्रस्य मारणम् ।
दृष्टप्रत्ययसंयुक्तमुक्तवान् रसकौतुकी ॥ 40.
विलिप्तं मत्कुणस्यास्रै सप्तवारं विशोषितम् ॥
कासमर्दरसापूर्णे लोहपात्रे निवेशितम् ।
सप्तवारं परिध्मातं वज्रभस्म भवेत् खलु ॥
ब्रह्मज्योतिर्मुनीन्द्रेण क्रमोऽयं परिकीर्त्तितः । 41-43.

(1) परिमर्द्य च, another reading in the Poona ed., which does not agree with B. and K.

मदनस्य फलोद्भूतरसेन क्षोणिनागकैः ।
कृतकल्केन संलिप्य पुटेद्विंशतिवारकम् ॥
वज्रचूर्णं भवेद्वर्य्यं योजयेच्च रसादिषु ॥ 44-45.

अथ रत्नभस्मक्रमः—

लकुचद्रावसंपिष्टैः शिलागन्धकतालकैः ।
वज्रं विनान्यरत्नानि म्रियन्तेऽष्टपुटैः खलु ॥ 63.
रामठं पञ्चलवणं क्षाराणां त्रितयं तथा ।
मांसद्राव्याम्लवेतस[1] चूलिकालवणं तथा ॥
स्थूलं कुम्भीफलं पक्वं तथा ज्वालामुखी शुभा ।
द्रवन्ती च रुदन्ती च पयस्या चित्रमूलकम् ॥
दुग्धं स्नुह्यास्तथार्कस्य सर्व्वं संमर्द्य यत्नतः ।
गोलं विधाय तन्मध्ये प्रक्षिपेत् तदनन्तरम् ॥
गुणवद्वररत्नानि जातिमन्ति शुभानि च ।
भूर्जे तं गोलकं कृत्वा सूत्रेणावेष्ट्य यत्नतः ॥

(1) मांसद्राव्याम्लवेतस, a variant in the Poona ed., which we have adopted and which also agrees with B. and K.

पुनर्वस्त्रेण संवेष्ट्य दोलायन्त्रे निधाय च ।
सर्व्वाम्लयुक्तसन्धानपरिपूर्णघटोदरे ॥
अहोरात्रत्रयं यावत् स्वेदयेत्तीव्रवह्निना ।
तस्मादाहृत्य सङ्क्षाल्य रत्नजां द्रुतिमाहरेत् ॥ 64-69.
मुक्ताचूर्णन्तु सप्ताहं वेतसाम्लेन मर्द्दितम् ।
जम्बीरोदरमध्ये तु धान्यराशौ विनिक्षिपेत् ॥
सप्ताहादुद्धृतञ्चैव पुटे दत्त्वा द्रुतिं हरेत्[1] । 70-71.
वज्रवल्ल्यन्तरस्थञ्च कृत्वा वज्रं निरोधयेत् ।
अम्लभाण्डगतं स्वेद्यं सप्ताहाद्द्रवतां व्रजेत् ॥ 72.

अथ वैक्रान्तम्—

श्वेतवर्णन्तु वैक्रान्तमम्लवेतसभावितम् ।
सप्ताहान्नात्र सन्देहः खरघर्म्मे द्रवत्यलम् ॥ 73.
केतकीस्वरसो ग्राह्यः सैन्धवं स्वर्णपुष्पिका ।
इन्द्रगोपकसंयुक्तं सर्व्वं भाण्डे विनिक्षिपेत् ॥
सप्ताहं स्वेदयेदस्मिन् वैक्रान्तं द्रवतां व्रजेत् । 74-75.

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(1) द्रुतिं हरेत्, a variant in the Poona ed., which we have adopted.

अथ पञ्चमोऽध्यायः ।

अथ लोहानि ।

अथ हेमगुणाः—

शुद्धं लोहं कनकरजतं भानुलोहाश्मसारं
पूतीलोहं द्वितयमुदितं नागवङ्गाभिधानम् ।
मिश्रं लोहं त्रितयमुदितं पित्तलं कांस्यवर्त्तं
धातुर्लोहे लुह इति मतः सोऽप्यनेकार्थवाची[1] ॥1.

प्राकृतं सहजं वह्निसम्भूतं खनिसम्भवम् ।
रसेन्द्रवेधसञ्जातं स्वर्णं पञ्चविधं स्मृतम् ॥ 2.
सौख्यं वीर्य्यं बलं हन्ति रोगवर्गं करोति च ।
अशुद्धं न सृतं स्वर्णं तस्माच्छुद्धं समाचरेत् ॥ 11.

सुवर्णपत्रं तनु कर्षमानं[2]
शरावकुद्धं पटुधातुयुक्तम् ।

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(1) सोऽप्यनेकार्थवाची, a variant in the Poona ed., which we have adopted.

(2) सुवर्णपत्रं तनु कर्षमानं, another reading in the Poona ed., which we have accepted.

अङ्गारसंस्थं प्रहरार्द्धमानं
ध्मानेन तत् स्यान्ननु पूर्णवर्णम्[1] ॥ 12.
लोहानां मारणं श्रेष्ठं सर्व्वेषां रसभस्मना ।
मूलीभिर्मध्यमं प्राहुः कनिष्ठं गन्धकादिभिः ॥ 13.
अरिलोहेन लोहस्य मारणं दुर्गुणप्रदम् ।
कृत्वा कण्टकवेध्यानि स्वर्णपत्राणि लेपयेत् ।
लुङ्गाम्बुभस्मसूतेन म्रियते दशभिः पुटैः ॥ 14.
द्रुते विनिक्षिपेत् स्वर्णे लोहमानं मृतं रसम् ।
विचूर्ण्य लुङ्गतोयेन दरदेन समन्वितम् ॥
जायते कुङ्कुमच्छायं स्वर्णं द्वादशभिः पुटैः ॥
15-16.
हेम्नः पादं मृतं सूतं पिष्टमम्लेन केनचित् ।
पत्रे लिप्त्वा पुटैः पाच्यं दशभि[2]र्म्रियते ध्रुवम् ॥ 17.

(1) पूर्णवर्णं, a different reading in the Poona ed., which we have retained.

(2) पुटैः पाच्यं दशभिः, a variant in the Poona ed., which we have adopted.

अथ रजतम्—

सहजं खनिसञ्जातं कृत्रिमं च त्रिधा मतम् ॥ 22.
नागेन टङ्कणेनैव वापितं शुद्धिमृच्छति ।
खर्परे भस्मचूर्णाभ्यां पचितः पालिकां चरेत् ॥
तत्र रूप्यं विनिक्षिप्य समसीससमन्वितम् ।
जातसीसक्षयं यावद्धमेत तावत् पुनः पुनः ॥
इत्थं संशोधितं रूप्यं योजनीयं रसादिषु । 32-34.
लकुचद्रवसूताभ्यां तारपत्रं प्रलेपयेत् ॥
ऊर्द्ध्वाधो गन्धकं दत्त्वा मूषामध्ये निरुध्य च ।
स्वेदयेद्वालुकायन्त्रे दिनमेकं दृढाग्निना ॥
स्वाङ्गशीतां च तां पिष्टिं साम्लतालेन मर्द्दिताम् ।
पुटेद्द्वादशवाराणि भस्मीभवति रूप्यकम् ॥
35-37.

माक्षीकचूर्णलुङ्गाम्लमर्द्दितं पुटितं शनैः ।
त्रिंशद्वारेण तत् तारं भस्मसाज्जायतेतराम् । 38.

(1) च त्रिधा, another reading in the Poona ed., which also agrees with B. and K.

तारपत्रं चतुर्भागं भागैकं शुद्धतालकम् ।
मर्द्यं[1] जम्बीरजद्रावैस्तारपत्राणि लेपयेत् ॥
शोषयेदन्धयन्त्रे च त्रिंशदुपलकैः पचेत् ।
चतुर्दशपुटैरेवं निरुत्थं जायते ध्रुवम् ॥ 40-41

अथ ताम्रम्—

म्लेच्छं नेपालकं चेति तयोर्नेपालमुत्तमम् ।
नेपालादन्यखन्युत्थं म्लेच्छमित्यभिधीयते ॥ 44.
जम्बीररससंपिष्टरसगन्धकलेपितम् ।
शुल्वपत्रं शरावस्थं त्रिपुटैर्याति पञ्चताम् ॥ 55.

अथायः—

मुण्डं तीक्ष्णं च कान्तं च त्रिप्रकारमयः स्मृतम् ।

अथ मुण्डम्—

मृदु कुण्ठं कडारं च त्रिविधं मुण्डमुच्यते ॥ 70.
द्रुतद्रावमविस्फोटं चिक्कणं मृदु तच्छुभम् ।
हतं यत्प्रसरेद्दुःखात् तत्कुण्ठं मध्यमं स्मृतम् ॥
यद्धतं भज्यते भङ्गे कृष्णं स्यात्तत्कडारकम् ॥ 71 72.

(1) The Poona ed. reads मर्दं, which is grammatically inaccurate.

अथ तीक्ष्णम्—

* * * षड्विधं तीक्ष्णमुच्यते ॥ 75.

पक्वं पोगरोन्मुक्तं भङ्गे पारदवच्छवि ।
नमने भङ्गुरं यत् तत् खरलोहमुदाहृतम ॥ 76
वेगभङ्गुरधारं[1] यत् सारलोहं तदीरितम ॥ 78.

अथ कान्तम्—

भ्रामकं चुम्बकं चैव कर्षकं द्रावकं तथा ।
एवं चतुर्विधं कान्तं रोमकान्तं च पञ्चमम् ॥
एकद्वित्रिचतुःपञ्चसर्व्वतोमुखमेव तत् ।
पीतं कृष्णं तथा रक्तं त्रिवर्णं स्यात् पृथक् पृथक् ॥ 84-85.

भ्रामयेल्लोहजातं तु तत् कान्तं भ्रामकं मतम् ।
चुम्बयेच्चुम्बकं कान्तं कर्षयेत् कर्षकं तथा ।
साक्षाद्यद्द्रावयेल्लोहं तत् कान्तं द्रावकं भवेत् ॥
तद्रोमकान्तं स्फुटिताद्यतो रोमोद्गमो भवेत् । 88-89.

मदोन्मत्तगजः सूतः कान्तमङ्कुशमुच्यते ॥

(1) The Poona ed. reads वेगभङ्गुरधारम्, which is grammatically inaccurate.

सेचं ज्ञात्वा ग्रहीतव्यं तत्प्रयत्नेन धीमता ।
मारुतातपविक्षिप्तं वर्जयेन्नात्र संशयः ॥ 92-93.

पात्रे[1] यस्य प्रसरति जले तैलबिन्दुर्न लिप्तं
गन्धं हिङ्गु त्यजति च तथा तिक्ततां निम्बकल्कः ।
पाके दुग्धं भवति शिखराकारकं[2] नैति भूमिं
कान्तं लोहं तदिदमुदितं लक्षणोक्तं न चान्यत् ॥ 94.

रेतितं घृतसंयुक्तं क्षिप्त्वायः खर्परे पचेत् ।
चालयेल्लोहदण्डेन यावत् क्षिप्तं द्रवं दहेत् ॥
पिष्ट्वा पिष्ट्वा पचेदेवं पञ्चवारमतः परम् ।
धात्रीफलरसैर्यद्वा त्रिफलाक्वथितोदकैः ।
पुटेल्लोहं चतुर्वारं भवेद्वारितरं खलु ॥ 104-105.

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(1) Cf. यत्पात्रे न प्रसरति जले तैलबिन्दुः प्रतप्ते
हिङ्गुर्गन्धं त्यजति च निजं तिक्ततां निम्बकल्कः ।
तप्तं दुग्धं भवति शिखराकारकं नैति भूमिं
कृष्णाङ्गं स्यात् सजलचणकः कान्तलौहं तदुक्तम् ॥

भावप्रकाशे कान्तलौहप्रकरणम् ।

(2) A variant in the Poona ed., which agrees with the भावप्रकाश, as quoted in the foot note.

तीक्ष्णलोहस्य पत्राणि निर्दलानि दृढेऽनले ।
ध्मात्वा क्षिपेज्जले सद्यः पाषाणोलूखलोदरे ॥
खण्डयेद्गाढनिर्घातैः स्थूलया लोहपारया ।
तन्मध्यात्[1] स्थूलखण्डानि रुद्ध्वा मल्लद्वयान्तरे ॥
ध्मात्वा क्षिप्त्वा जले सम्यक् पूर्व्ववत् कण्डयेत् खलु ।
तच्चूर्णं सूतगन्धाभ्यां पुटेद्विंशतिवारकम् ॥
पुटे पुटे विधातव्यं पेषणं दृढवत्तरम् ।
एवं भस्मीकृतं लोहं तत्तद्रोगेषु योजयेत् ॥

107-110.

जम्बीरैरारनालैर्वा विंशत्यंशेन हिङ्गुलम् ॥
पिष्ट्वा रुद्ध्वा पचेल्लोहं तद्द्रवैः पाचयेत् पुनः ।
चत्वारिंशत्पुटैरेवं कान्तं तीक्ष्णं च मुण्डकम् ॥
म्रियते नात्र सन्देहो दत्त्वा दत्त्वैव हिङ्गुलम् ।

113-115.

शुद्धसूतं द्विधा गन्धं खल्वे तु कृतकज्जलीम् ।
द्वयोः समं लोहचूर्णं मर्दयेत् कन्यकाद्रवैः ॥

(1) तन्मध्यात्, a reading in the Poona ed., which also agrees with B. and K.

ग्रामद्वयात् समुद्धृत्य तद्गोलं ताम्रपात्रके ।[1]
आच्छाद्यैरण्डपत्रैश्च यामार्द्धेऽत्युष्णता भवेत् ॥
धान्यराशौ न्यसेत् पश्चात् त्रिदिनान्ते समुद्धरेत् ।
संपेष्य गालयेद्वस्त्रे सत्यं वारितरं भवेत् ॥
कान्तं तीक्ष्णं च मुण्डं च निरुत्थं जायते ध्रुवम् ।
स्वर्णादीन् मारयेदेवं चूर्णं कृत्वा च लोहवत् ॥

134-137.

लोहकिट्टं सुसन्तप्तं यावज्जीर्य्यति तत् स्वयम् ।
तच्चूर्णं जायते पेष्यं मण्डूरोऽयं प्रयोज्यते ॥ 147.
ये गुणा मारिते मुण्डे ते गुणा मुण्डकिट्टके ।
तस्मात् सर्वत्र मण्डूरं रोगशान्त्यै प्रयोजयेत्॥ 148.

अथ वङ्गम्—

खुरकं मिश्रकं चेति द्विविधं वङ्गमुच्यते ।
खुरं तत्र गुणैः श्रेष्ठं मिश्रकं न हितं मतम् ॥ 153.
धवलं मृदुलं स्निग्धं द्रुतद्रावं सगौरवम् ।
निःशब्दं खुरवङ्गं स्यान्मिश्रकं श्यामशुभ्रकम् ॥ 154.

(1) ताम्रपात्रके, a reading in the Poona ed., which also agrees with B. and K.

वङ्गं तिक्तोष्णकं रुक्षमीषद्वातप्रकोपनम् ।
मेहश्लेष्मामयघ्नं च मेदोघ्नं क्रिमिनाशनम् ॥ 155.
द्रावयित्वा निशायुक्ते क्षिप्तं निर्गुण्डिकारसे ।
विशुध्यति त्रिवारेण खुरवङ्गं न संशयः ॥ 156.
सतालेनार्कदुग्धेन लिप्त्वा वङ्गदलान्यथ ।[1]
वोधिचिञ्चात्वचः क्षारैर्दद्यात्सप्तपुटानि च ॥
मर्दयित्वा चरेद्भस्म * * * ॥ 159-160.

अथ सीसकम्—

द्रुतद्रावं महाभारं छेदे कृष्णसमुज्ज्वलम् ।
पूतिगन्धं बहिःकृष्णं शुद्धं सीसमतोऽन्यथा ॥ 171.
पञ्चविंशतिकं नागमधस्तीव्रानलं क्षिपेत् ।
द्रुते नागे क्षिपेत् सूतं शुद्धं कर्षमितं शुभम ॥
विघट्य निक्षिपेत् क्षारमेकैकं हि पलं पलम् ।
अर्जुनस्याश्वत्थस्य महाराजगिरेरपि ।
दाडिमस्य मयूरस्य क्षिप्त्वा क्षारं पृथक् पृथक् ॥

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(1) अथ, a variant in the Poona ed., which also agrees with B. and K.

एवं विंशतिरात्राणि पचेन तीव्रेण वह्निना ।
विघट्टयन् दृढ़ं दोर्भ्यां लोहदर्व्या प्रयत्नतः ॥
रक्तं तज्जायते भस्म कपोतच्छायमेव वा ।
176-179.

शिलया रविदुग्धेन नागपत्राणि लेपयेत् ॥
मारयेत् पुटयोगेन निरुत्थं जायते तथा । 184-185.

अथ पित्तलम्—

रीतिका काकतुण्डी च द्विविधं पित्तलं भवेत् ।
सन्तप्ता काञ्जिके क्षिप्ता ताम्राभा रीतिका मता ॥
एवं या जायते कृष्णा काकतुण्डीति सा मता ॥
192-193.

गुर्व्वी मृद्वी च पीताभा साराङ्गी ताड़नक्षमा ।
सुस्निग्धा मसृणाङ्गी च रीतिरेतादृशी शुभा ॥ 195.
पूतिगन्धा तथा लघ्वी रीतिर्नेष्टा रसादिषु ॥ 196.
निम्बूरसशिलागन्धवेष्टिता पुटिताष्टधा ।
रीतिरायाति भस्मत्वं ततो योज्या यथायथम् ॥
ताम्रवन्मारणं तस्याः कृत्वा सर्व्वत्र योजयेत् ।
201-202.

अथ कांस्यम्—

षड्भागेन ताम्रेण द्विभागकुटिलेन च ।
विद्रुतेन भवेत् कांस्यं * * * ॥ 205.
म्रियते गन्धतालाभ्यां निरुत्थं पञ्चभिः पुटैः ॥ 210.

अथ वर्त्तलोहम्—

कांस्यार्करीतिलोहाहिजातं तद्वर्त्तलोहकम् ।
तदेव पञ्चलोहाख्यं लोहविद्भिरुदाहृतम् ॥ 212.
म्रियते गन्धतालाभ्यां पुटितं वर्त्तलोहकम् । 216.

अथ षष्ठोऽध्यायः ।

अथ शिष्योपनयनम् ।

आचार्य्यो ज्ञानवान् दक्षो रसशास्त्रविशारदः ।
मन्त्रसिद्धो महावीरो निश्चलः शिववत्सलः ॥
देवीभक्तः सदाधीरो देवतायागतत्परः ।
सर्वाम्नायविशेषज्ञः कुशलो रसकर्म्मणि ॥

एवं लक्षणसंयुक्तो रसविद्यागुरुर्भवेत् ।
गुरुभक्ताः सदाचाराः सत्यवन्तो दृढ़व्रताः ॥
निरालस्याः स्वधर्मज्ञाः सदाज्ञापरिपालकाः ।
दम्भमात्सर्य्यनिर्मुक्ताः कुलाचारेषु दीक्षिताः ॥
अत्यन्तसाधकाः शान्ता मन्त्राराधनतत्पराः ।
इत्येवं लक्षणैर्युक्ताः शिष्याः स्युः कार्य्यसिद्धये ॥3-7.
आतङ्करहिते देशे धर्म्मराज्ये मनोरमे ।
उमामहेश्वरोपेते समृद्धे नगरे शुभे ॥
कर्त्तव्यं साधनं तत्र रसराजस्य धीमता ।
अत्यन्तोपवने रम्ये चतुर्द्वारोपशोभिते ॥
तत्र शाला प्रकर्त्तव्या सुविस्तीर्णा मनोरमा ।
सम्यग्वातायनोपेता दिव्यचित्रैर्विचित्रिता ॥
13-15.

निष्कत्रयं हेमपत्रं रसेन्द्रं नवनिष्ककम् ।
अम्लेन मर्दयेद्यामं तेन लिङ्गं तु कारयेत् ॥
तल्लिङ्गं पूजयेत् तत्र सुशुभैरुपचारकैः ॥
लिङ्गकोटिसहस्रस्य यत् फलं सम्यगर्चनात् ।
तत् फलं कोटिगुणितं रसलिङ्गार्चनाद्भवेत् ॥

ब्रह्महत्यासहस्राणि स्त्रीगोहत्यायुतानि[1] च ।
तत्क्षणाद्विलयं यान्ति रसलिङ्गस्य दर्शनात् ॥
19-22.

रसविद्या[2] शिवेनोक्ता दातव्या साधकाय वै ।
यथोक्तेन विधानेन गुरुणा मुदितात्मना ॥ 30.
कोष्ठी मूषा वङ्कनाली तुषाङ्गारवनोपलाः ॥
भस्त्रिका दण्डिकानेकाः शिलाखल्वान्युलूखलम् ।

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अनेन मूलमन्त्रेण भैरवं तत्र पूजयेत् ।
सर्व्वेषां रससिद्धानां नाम सङ्कीर्त्तयेत्तदा ॥

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सप्तविंशतिसंख्याका रससिद्धिप्रदायकाः ।
वन्द्याः पूज्याः प्रयत्नेन ततः कुर्य्याद्रसार्चनम् ॥
52-61.

(1) स्त्रीगोहत्यायुतानि च, a variant in the Poona ed., which we have adopted.

(2) B. and K. read रसदीक्षा ।

स्पर्शयेद्दिजदेवानां नर्पयेदिष्टदेवताः ।
कुमारीयोगिनीयोगीश्वरान् म्लेच्छकसाधकान्[1] ॥ 62.

रसविद्या दृढं गोप्या मातुर्गुह्यमिव ध्रुवम् ।
भवेद्वीर्य्यवती गुप्ता निर्वीर्य्या च प्रकाशनात् ॥70.

अथ सप्तमोऽध्यायः ।

अथ रसशाला ।

रसशालां प्रकुर्व्वीत सर्व्ववाधाविवर्ज्जिताम् ।
सर्व्वौषधमये देशे रम्यकूप[2]समन्विते ॥
नानोपकरणोपेतां प्राकारेण सुशोभिताम् ॥
शालायाः पूर्व्वदिग्भागे स्थापयेद्रसभैरवम् ।
वह्रिकर्म्माणि चाग्नेये याम्ये पाषाणकर्म्म च ॥

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(1) म्लेच्छकसाधकान्, a variant in the Poona ed., which also agrees with B.

(2) रम्यकूप, a variant in the Poona ed., which we have adopted.

नैर्ऋत्ये शस्त्रकर्माणि वारुणे चालनादिकम्।
शोषणं वायुकोणे च वेधकर्मोत्तरे तथा॥
स्थापनं सिद्धवस्तूनां प्रकुर्यादीशकोणके।
पदार्थसङ्ग्रहः कार्य्यो रससाधनहेतुकः॥
सत्त्वपातनकोष्ठीच सुराकोष्ठीं सुशोभनाम्।
भूमिकोष्ठीं चलत्कोष्ठीं जलद्रोणीरनेकशः॥
भस्त्रिकायुगलं तद्वच्चलिते वंशलोहयोः।

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करणानि विचित्राणि द्रव्याण्यपि समाहरेत्।
कण्डनीं पेषणीं खल्लान् द्रोणीरूपांश्च वर्त्तुलान्।
सूक्ष्मच्छिद्रसहस्राढ्यां द्रव्यगालनहेतवे।
चालनीश्च कटचाणि * * * ॥
मूषामृत्तुषकार्पासवनोपलकपिट्टकम्।
काचायोमृद्वराटानां कूपिकाचषकानि च। 1-18.
निर्लोभाः सत्यवक्तारो देवब्राह्मणपूजकाः।
यमिनः पथ्यभोक्तारो योजनीया रसायने॥ 30.
तत्तदौषधनामज्ञाः शुचयो वञ्चनोज्झिताः।
नानाविषयभाषाज्ञास्ते मता भेषजाहृतौ॥ 32.

अथ अष्टमोऽध्यायः ।

अथ परिभाषा ।

कथ्यते सोमदेवेन मुग्धवैद्यप्रबुद्धये ।
परिभाषा रसेन्द्रस्य शास्त्रैः सिद्धैश्च भाषिता ॥ 1.

अर्हं सिद्धरसस्य तैलघृतयोर्लौहस्य भागोऽष्टमः
संसिद्धाखिललौहचूर्णवटकादीनां तथा सप्तमः ।
यो दीयेत भिषग्वराय गदिभिर्निर्दिश्य धन्वन्तरिं
सर्व्वारोग्यसुखाप्तये निगदितो भागः स धन्वन्तरेः ॥ 2.

धातुभिर्गन्धकाद्यैश्च निर्द्रवैर्मर्दितो रसः ।
सुश्लक्ष्णः कज्जलाभोऽसौ कज्जलीत्यभिधीयते ॥
सद्रवा मर्दिता सैव रसपङ्क इति स्मृतः ॥ 5-6.
मृतं तरति यत्तोये लोहं वारितरं हि तत् ।
अङ्गुष्ठतर्ज्जनीघृष्टं यत्तद्रेखान्तरं[1] विशेत् ॥
मृतं लोहं तदुद्दिष्टं रेखापूर्णाभिधानतः ॥

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(1) रेखान्तरं, a variant in the Poona ed. which we have adopted.

गुड़गुञ्जासुखस्पर्शमध्वाज्यैः[1] सह योजितम् ।
नायाति प्रकृतिं ध्मानादपुनर्भवमुच्यते ॥
तस्योपरि गुरु द्रव्यं धान्यं चोपनयेद्ध्रुवम् ।
हंसवत् तीर्य्यते वारिष्वुत्तमं परिकीर्त्तितम् ॥
25-28.

रौप्येण सह संयुक्तं ध्मातं रौप्ये[2] न चेन्नगेत् ।
तदा निरुत्थमित्युक्तं लोहं तदपुनर्भवम् ॥ 29.
तीक्ष्णं नीलाञ्जनोपेतं ध्मातं हि बहुशो दृढ़म् ।
मृदुकृष्णं द्रुतद्रावं वरनागं[3] तदुच्यते ॥ 38.

(1) Cf. घृतमधुगुञ्जाटङ्कैः सर्वं लौहभस्म मर्दयेच विचक्षणः ।
धमेद्वह्नौ यदा पुनर्लौहभावं न गच्छेत् तदा योज्यं रसायने ।
लौहभावं यदा गच्छेत् तं पुनर्मारयेत् सुधीः ।
रसचन्द्रिका जारणमारणाध्यायः ।

(2) We have adopted the reading in B. and K. The Poona ed., however, reads रौप्येण चेन्नगेत्, which, from the chemical point of view, is untenable.

(3) वरनागं, a variant in the Poona ed., which also agrees with B.

सूतस्य पुनरुद्भूतिः सम्योक्तोत्थापनाख्यया । 39.
इयन्मानस्य सूतस्य भोज्यद्रव्यात्मिका मतिः ।
इयतीत्युच्यते ग्रासो ग्रासमानमितीरितम् ॥ 64.
चतुःषष्ठ्यंशतो बीजप्रक्षेपो मुखमुच्यते ।
एवङ्कृते रसो ग्रासलोलुपो मुखवान् भवेत् ॥
कठिनान्यपि लोहानि क्षमो भवति भक्षितुम् । 68-69.
लेपः क्षेपश्च कुन्तश्च धूमाख्यः शब्दसंज्ञकः ।
लेपेन कुरुते लोहं स्वर्णं वा रजतं तथा ॥ 80.
वह्नौ धूमायमानेऽन्तः प्रक्षिप्तरसधूमतः
स्वर्णाद्यापादनं लोहे धूमवेधः स ईरितः ॥ 83.
मुखस्थितरसेनाल्पलोहस्य दमनात् खलु ।
स्वर्णरूप्यत्वजननं शब्दवेधः स कीर्त्तितः । 84

रसनिगममहाब्धेः सोमदेवः समन्तात्
स्फुटतरपरिभाषानामरत्नानि हृत्वा ।
व्यरचयदतियत्नात् तैरिमां कण्ठमालां
कलयतु[1] भिषगग्र्यो मण्डनार्थं सभायाम् ॥ 89.

(1) कलयत, another reading in the Poona ed., which we have adopted.

अथ नवमोऽध्यायः ।

अथ यन्त्राणि ।

अथ यन्त्राणि वक्ष्यन्ते रसतन्त्राद्यशेषतः ।
समालोक्य समासेन सोमदेवेन साम्प्रतम् ॥ 1.

अथ दोलायन्त्रम्—

द्रवद्रव्येण भाण्डस्य पूरितार्द्धोदरस्य च ।
मुखमुभयतो द्वारद्वयं कृत्वा प्रयत्नतः ॥ 3.
तयोस्तु निक्षिपेद्दण्डं तन्मध्ये रसपोटलीम् ।
बद्धा तु स्वेदयेदेतद्दोलायन्त्रमिति स्मृतम् ॥ 4.

अथ स्वेदनीयन्त्रम्—

साम्बुस्थालीमुखावद्धे वस्त्रे पाक्यं निवेशयेत् ।
पिधाय पच्यते यत्र स्वेदनीयन्त्रमुच्यते ॥ 5.

अथ पातनायन्त्रम्—

अष्टाङ्गुलपरिणाहमानाहेन दशाङ्गुलम् ।
चतुरङ्गुलकोत्सेधं तोयाधारं गलादधः ॥
अधोभाण्डे मुखं तस्य भाण्डस्योपरिवर्त्तिनः ।
षोड़शाङ्गुलविस्तीर्णपृष्ठस्यास्ये प्रवेशयेत् ॥

पार्श्वयोर्म्महिषीक्षीरचूर्णमण्डूरफाणितैः ।
लिप्त्वा विशोषयेत् सन्धिं जलाधारे जलं क्षिपेत् ।
चुल्ल्यामारोपयेदेतत् पातनायन्त्रमीरितम् ॥ 6-8.

अथाधःपातनायन्त्रम्—

अथोर्द्धभाजने[1] लिप्तं स्थापितस्य जले सुधीः ।
दीप्तैर्व्वनोपलैः कुर्य्यादधःपातं प्रयत्नतः ॥ 9.

अथ दीपिकायन्त्रम्—

कच्छपयन्त्रान्तर्गतमृन्मयपीठस्थदीपिकासंस्थः ।
यस्मिन्निपतति सूतः प्रोक्तं तद्दीपिकायन्त्रम् ॥ 10.

अथ ढेकीयन्त्रम्—

भाण्डकण्ठादधश्छिद्रे वेणुनालं विनिक्षिपेत् ।
कांस्यपात्रद्वयं कृत्वा सम्पुटं जलगर्भितम् ॥
नलिकास्यं तत्र योज्यं दृढं तत्रापि कारयेत् ।
युक्तद्रव्यैर्विनिक्षिप्तः पूर्व्वं तत्र घटे रसः ।
अग्निना तापितो नालात्तोये तस्मिन् पतत्यधः ॥
यावदुष्णं भवेत्सर्व्वं भाजनं तावदेव हि ।
जायते रससन्धानं ढेकीयन्त्रमितीरितम् ॥ 11-14.

(1) K. reads अथ, which we have retained.

अथ वालुकायन्त्रम्—

सरसां गूढवक्त्रां मृद्वस्त्राङ्गुलघनावृताम्।
शोषितां काचकलशीं पूरयेत् त्रिषु भागयोः॥
भाण्डे वितस्तिगम्भीरे वालुका सुप्रतिष्ठिता।
तद्भाण्डं पूरयेत् त्रिभिरन्याभिरवगुण्ठयेत्॥
भाण्डवक्त्रं माणिकया सन्धिं लिम्पेन्मृदा पचेत्।
चुल्ल्यां तृणस्य चादाहान्मणिकापृष्ठवर्त्तिनः॥
एतद्धि वालुकायन्त्रं तद्यन्त्रं लवणाश्रयम्॥ 34-36.

अथ लवणयन्त्रम्—

एवं लवणनिक्षेपात् प्रोक्तं लवणयन्त्रकम्। 38.

अथ नालिकायन्त्रम्—

लोहनालगतं सूतं भाण्डे लवणपूरिते।
निरुद्धं विपचेत् प्राग्वन्नालिकायन्त्रमीरितम्॥ 41

अथ तिर्यक्पातनयन्त्रम्—

क्षिपेद्रसं घटे दीर्घनताधोनालसंयुते।[1]
तन्नालं निक्षिपेदन्यघटकुक्ष्यन्तरे खलु॥

(1) दीर्घनताधो, a variant in the Poona ed., which also agrees with B. and K.

तत्र रुद्ध्वा मृदा सम्यग्वदने घटयोरध: ।
अधस्ताद्रसकुम्भस्य ज्वालयेत् तीव्रपावकम् ॥
इतरस्मिन् घटे तोयं प्रक्षिपेत् स्वादुशीतलम् ।
तिर्यक्पातनमेतद्धि वार्त्तिकैरभिधीयते ॥ 48-50.

अथ हिङ्गुलाकृष्टिविद्याधरयन्त्रम्—

स्थालिकोपरि विन्यस्य स्थालीं सम्यङ्निरुध्य च ।
ऊर्द्ध्वस्थाल्यां जलं क्षिप्त्वा वह्निं प्रज्वालयेदध: ॥
एतद्विद्याधरं यन्त्रं हिङ्गुलाकृष्टिहेतवे ॥ 57-58.

अथ धूपयन्त्रम्—

विधायाष्टाङ्गुलं पात्रं लौहमष्टाङ्गुलोच्छ्रयम् ।
कण्ठाधो द्व्यङ्गुले देशे गलाधारे हि तत्र च ॥
तिर्यग्लोहशलाकाश्च तन्वीस्तिर्यग्विनिक्षिपेत् ।
तनूनि स्वर्णपत्राणि तासामुपरि विन्यसेत् ॥
पात्राधो निक्षिपेद्धूमं वक्ष्यमाणमिहैव हि ।
तत् पात्रं न्युब्जपात्रेण च्छादयेदपरेण हि ॥
मृदा विलिप्य सन्धिं च वह्निं प्रज्वालयेदध: ।
तेन पत्राणि कृष्णानि[1] हतान्युक्तविधानत: ॥

(1) कृष्णानि, another reading in the Poona ed., which we have accepted.

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गन्धालकशिलानां हि कज्जल्या वा मृताहिना ॥
धूपनं स्वर्णपत्राणां प्रथमं परिकीर्त्तितम् ।
तारार्थं तारपत्राणि मृतवङ्गेन धूपयेत् ॥
धूपयेच्च यथायोग्यैरन्यैरुपरसैरपि ।
धूपयन्त्रमिदं प्रोक्तं जारणाद्द्रव्यसाधनम् ॥ 70-76.

अथ दशमोऽध्यायः ।

अथ मूषादिकथनम् ।

मृत्तिका पाण्डुरस्थूला शर्करा शोणपाण्डुरा ।
चिराध्मानसहा सा हि मूषार्थमतिशस्यते ॥
तदभावे हि वाल्मीकी कौलाली वा समीर्यते ॥

या मृत्तिका दग्धतुषैः शणेन
शिखित्रकैर्वा हयलद्दिना च ।
लोहेन दण्डेन च कुट्टिता सा
साधारणी स्यात् खलु मूषिकार्थम्[1] ॥ 5-6.

(1) स्यात् and मूषिकार्थे are two different readings in the Poona ed., which we have adopted.

अथ पुटानि—

लोहादेरपुनर्भावो गुणाधिक्यं ततोऽग्रता ।
अनप्सु मज्जनं रेखापूर्णता पुटतो भवेत् ॥ 51.
निम्ने विस्तरतः कुण्डे द्विहस्ते चतुरस्रके ।
वनोपलसहस्रेण पूरिते पुटनौषधम् ॥
कोष्ठ्यां[1] रुद्धं प्रयत्नेन पिष्टिकोपरि निक्षिपेत् ।
वनोपलसहस्रार्धं कोष्ठिकोपरि विन्यसेत् ॥
वह्निं प्रज्वालयेत् तत्र महापुटमिदं स्मृतम् ।54-56.
सुवर्णं रजतं ताम्रं त्रपु सीसकमायसम् ।
षडेतानि च लोहानि कृत्रिमे कांस्यपित्तले ॥ 70.
लवणानि षडुच्यन्ते सामुद्रं सैन्धवं विडम् ।
सौवर्चलं रोमकं च चूलिकालवणं तथा ॥
क्षारत्रयं समाख्यातं यवसर्जिकटङ्कणम् ॥ 71.

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जम्बूकमण्डूकवसा वसा कच्छपसम्भवा ।

(1) कोष्ठ्यां, a variant in the Poona ed., which we have adopted.

कर्कोटी शिशुमारो च गोधूकरनरोद्भवा ।
अजोष्ट्रखरमेषाणां महिषस्य वसा तथा ॥ 76 7-7.
मूत्राणि हस्तिकरभमहिषीखरवाजिनाम् ।
गोऽजावीनां स्त्रियः पुंसां पुष्पं वीजं तु योजयेत् ॥
78.

चाङ्गेरीचणकाम्लं च अम्लिकं कोलदाड़िमम् ।
अम्लष्ठा तिन्तिड़ीकं च नारङ्गं रसपत्रिका ।
करवन्दं तथा चान्यदम्लवर्गः प्रकीर्त्तितः ॥
चणकाम्लश्च सर्व्वेषामेक एव प्रशस्यते ॥
अम्लवेतसमेकं वा सर्व्वेषामुत्तमोत्तमम् ।
रसादीनां विशुद्धार्थं द्रावणे जारणे हितम् ॥
कोलदाड़िमवृक्षाम्लचुल्लिकाचुक्रिकारसम् ।
पञ्चाम्लकं समुद्दिष्टं तच्चोक्तं चाम्लपञ्चकम् ॥
80-84.

इष्टिका गैरिका लोणं भस्म वल्मीकमृत्तिका ।
रसप्रयोगकुशलैः कीर्त्तिताः पञ्च मृत्तिकाः ॥ 85.
शृङ्गीकं कालकूटं च वत्सनाभं सक्तुचिमम् ।
पित्तं च विषवर्गोऽयं स वरः परिकीर्त्तितः ॥ 86.

लाङ्गली विषमुष्टिश्च करवीरजटा तथा ।
नलिकः कनकोऽर्कश्च वर्गो ह्युपविषात्मकः ॥ 88.
गुड़गुग्गुलुगुञ्जाज्यसारघैष्टङ्कणान्वितैः ।
द्रुद्रावाखिललोहादेर्द्रावणाय गणो मतः ॥ 100.

अथैकादशोऽध्यायः ।

अथ रसशोधनादिकथनम् ।

रसार्णवादिशास्त्राणि निरीक्ष्य कथितं मया ।
रसोपयोगि यत्किञ्चिद्द्रव्याद्यं तत्प्रदर्शितम् ।
अधुना रसराजस्य संस्कारान् सम्प्रचक्ष्महे ॥ 10.
विषं वह्निर्मलश्चेति दोषा नैसर्गिकास्त्रयः ।
यौगिकौ नागवङ्गौ द्वौ * * * ॥ 14-15.
तस्मात् सूतविधानार्थं सहायैर्निपुणैर्युतः ।
सर्व्वोपस्कारमादाय रसकर्म्म समाचरेत् ॥ 20.
द्वे सहस्रे पलानां तु सहस्रं शतमेव वा ।

अष्टाविंशत् पलान्येव दश पञ्चैकमेव वा ॥
पलार्द्धेनैव कर्त्तव्यः संस्कारः सूतकस्य च ।
सुदिने शुभनक्षत्रे रसशोधनमाचरेत् ॥ 2122.

रसस्तु पादांशसुवर्णजीर्णः
पिष्टीकृतो गन्धकयोगतश्च ।
तुल्यांशगन्धैः पुटितः क्रमेण
निर्वीजनामा सकलामयघ्नः ॥ 72.
पिष्टीकृतैरभ्रकसत्त्वहेम-
तारार्ककान्तैः परिशारितो यः ।
हतस्ततः षड्गुणगन्धकेन
स वीजबद्धो विपुलप्रभावः ॥ 73.

काकोदुम्बरिकाया दुग्धेन सुभावितो हिङ्गुः ।
मर्दनपुटेन विधिना सूतं भस्मीकरोत्येव ॥ 111.
देवदालीं हरिकान्तामारनालेन पेषयेत् ।
तद्द्रवैः सप्तधा सूतं कुर्य्यान्मर्दितमूर्च्छितम् ॥
तत्सूतं खर्परे दद्यादत्त्वा दत्त्वा तु तद्द्रवम् ।
चुल्ल्युपरि पचेत्ताह्ना भस्म स्याल्लवणोपमम् ॥
112-113.

अपामार्गस्य वीजानि तथैरण्डस्य चूर्णयेत् ।
तच्चूर्णं पारदे देयं मूषायामधरोत्तरम् ॥
रुद्धा लघुपुटैः पश्चाच्चतुर्भिर्भस्मतां नयेत् ।

114-115.





Rasāyana
Sanskrit Lit — Rasāyana
Chemistry — Hindu